MICROSLICE 2

Operating Manual

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TL - 5017 - OM

Cambridge Instruments Ltd.,
Rustat Road,
Cambridge,
CB1 3QH.

Addendum 19/9/781

The Microslice 2 Dual Purpose Saw

The section dealing with Annular Blade Mounting, on page 29 of this instruction manual, should be deleted and replaced by the following.

Annular Blade Mounting

The blade may be removed without removing the chuck from the saw spindle. For this, the long screws in the holes marked with the letters A - H are removed and the saw, blade. still in place between its clamping rings, may be taken from the chuck. (fig. 2)

Before mounting the new blade, it should be inspected for damage and rejected if any deep scratches or heavy dents or pips are to be seen on the surface. The area which will come into contact with the clamping rings (both sides) should be scrupulously cleaned and very lightly smeared with a medium pressure LM lubricant. The lower clamping ring (ie the one containing the tapped holes) is then placed plain side downwards on to the blade mounting jig (fig. 3). The annular blade is placed in the jig and located centrally by the tapered aligning plug. This should be very carefully inserted into the annular blade to avoid any damage occuring to the blade. The upper clamping ring is then placed on top with the counterbored screw head holes uppermost. Align the screw holes of the two clamping rings and the blade in such a way that the numbered holes in the upper clamping ring coincide with the tapped holes in the lower one. Insert the shorter blade securing bolts into the numbered holes in the upper ring and lightly screw them into place.until just finger tight.

Set the torque wrench provided to a torque of about 100 gms/metre (9 lbs/ins) and gradually tighten the bolts to this torque in sequence 1, 2, 3, 4, etc.This will start to stretch the blade and the internal bore will increase, so that the taper plug will need to be gradually adjusted to minimise uneven stretching.

Continue this sequencial tightening by increasing the toque wrench setting by 100 gms/metre (9 lbs/ins) increments until a final tightening torque of 400 gms/metre (35 lbs/ins) is obtained. It is essential that these bolts are tightened in sequence at each stage.

The rim of the chuck is then cleaned and lubricated in a similar way to the blade, and the clamping ring assembly brought up to it, with the bolt heads outermost. Insert the longer securi bolts into the lettered holes in the outermost clamping ring and lightly screw them into the chuck until they are just finger tight. Final tightening is carried out in sequence A, B, C, etc with the torque wrench settings the same as for tightening the blade into the clamping rings.

Under these conditions, the blade will deflect by about 50 microns at a point 3 mm from the cutting edge, for an applied load of typically 200 gms/ 0.07 cm^2. The bore diameter should be about 83.06 mm.

Place the blade guard cover carefully over the cutting head and over the rubber seal on the back plate. Check that it is fully pushed back over the seal and firmly tighten the three knurled screws.

Screw the lubrication feed to the side of the blade guard (fig. 5). Take great care not to damage the the blade with the end of the feed tube. The feed tube is on a hemispherical ball joint to enable the lubricant flow to be directed on to the cutting edge of the blade. The joint should be adjusted so that the lubricant jet is bisected by the blade at a point just in front of where the specimen will meet the blade.

Microslice 2 Recirculating Pump Unit

1 Positioning the Microslice 2 on the Pump Unit

Mount the pump unit on a flat surface with the motor housing at the rear.
Position the Microslice 2 Precision Saw on the flat upper surface of the pump unit with the rear of the machine nearest to the pump housing.

2 Fitting the Drip Tray

The drip tray should be positioned under the cutting head such that the flexible hose passes over the left hand side of the Microslice 2 body. A hole is provided in the surface of the pump reservoir to locate the flexible lubricant return hose.

3 Modifying Existing Drip Trays

In some cases, a kit is provided to modify existing drip trays which have been supplied without flexible hoses. This consists of a hose, a brass connector with a washer and nut.
In this case, the drip tray must be drilled to provide a clearance hole for the brass connector. This hole should be positioned in the centre of the left hand side wall of the tray at the lowest possible point to allow for maximum drainage.
Insert the brass connector through the hole from the outside and secure with the nut and washer.
Fit the flexible hose over the outside of the connector and locate the other end in the hole in the upper surface of the lubricant pump reservoir.

4 Fitting the Lubricant Feed Tube

Firmly secure a second flexible hose to the outlet valve of the lubricant pump, situated at the front of the motor housing.
Feed this hose along the right hand side of the Microslice 2, clipping it to the saw body using the two screw positions securing the top cover.
Remove the standard lubricant feed nozzle and substitute the angled feed nozzle of the recirculatory system.
Adjust the angle and position of the new feed nozzle so that the jet is as close to the blade and as near to its cutting edge as possible. Secure it in this position by tightening the knurled locking nut.

5 Filling the Lubricant Reservoir

Remove the large black plug from the top surface of the reservoir at the left hand side of the pump body.
Fill the reservoir with a suitable lubricant to within 5 mm of the top surface. Replace the filler plug.

6 Electrical Power Connections

This is simply provided by inserting the plug on the power lead to the pump unit into the socket provided at the rear of the Microslice 2 body.

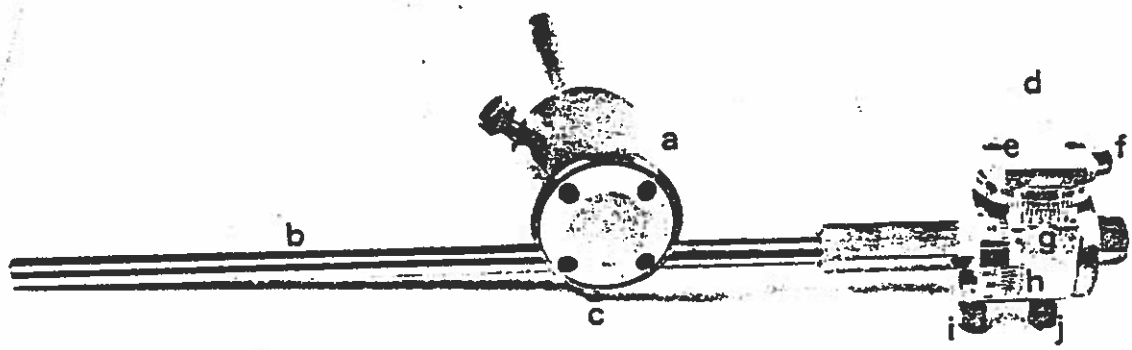
After switching on the main power, the lubricant feed flow rate may be adjusted by operating the control fitted to the lubricant feed adjacent to the motor body of the pump unit.

Use of the Precision Goniometer Attachment for the Microslice 2 Saw

The precision two circle goniometer attachment is designed to allow the reproducable transfer of specimens from the X - ray equipment used for sample orientation, to the counterbalance arm of the Microslice 2 saw.

The two axes of the goniometer are calibrated to +/- 5 degrees of zero, and are provide with vernier scales to enable adjustments to be made to within 30 minutes in each axis.

Prior to use, the work table must be set accurately at 90 degrees to the plane of the blade, with both axes set at zero. A right angle setting jig is provided to aid this adjustment.



The Goniometer Accessory In Position on the Pivot Housing

a	Pivot Housing of the Microslice 2 Saw
b	Goniometer Supporting Counterbalance Arm
c	Pivot Housing Support Arm Securing Screw
d	Goniometer Work Table
e	Work Table Securing Screws
f	Horizontal Axis Clamping Screw
g	Horizontal Axis Scale and Vernier
h	Vertical Axis Scale and Vernier
i	Goniometer Body Clamping Screw
J	Vertical Axis Clamping Screw

Fitting and Setting Up the Goniometer

1. Slacken the clamping screw in the pivot housing and remove the round section counterbalance arm. Insert the goniometer supporting arm, with the square end section positioned nearest to the blade, but do not as yet retighten the clamping clamping screw.

2. Carefully remove the centre locking screw from the blade chuck and replace by the right angle setting jig. Tighten this jig fully, and rotate the assembly until the arm of the jig is pointing downwards.

3. Set and clamp both axes of the goniometer at zero.

4. Slide the goniometer on to the squared section of the supporting arm, with the end carrying the vertical movement calibrations nearest to the pivot housing. Slide it along the squared section until it is adjacent to the arm of the setting jig and tighten the goniometer clamping screw to secure it to the support arm.

5. Rotate the goniometer supporting arm until the work table is pointing downwards and is parallel to the arm of the setting jig. When this has been achieved, fully tighten the counterbalance arm clamping screw in the pivot housing. If this settin is to be maintained, the clamping screw must not now be slackened at all.

6. Slacken the goniometer clamping screw and remove the goniometer from the suppo arm. If, after the sample has been secured to the work table, the goniometer is replaced on to the supporting arm with the work table at right angles to the blad then the table is accurately at right angles to the blade.

7. Unscrew the right angle setting jig from the centre of the blade chuck and replac the blade chuck securing screw, tightening it fully.

The goniometer is now set up ready for use when the specimen has been secured to the work table.

Mounting a Specimen to the Work Table

Remove the work table from the goniometer body by removing the two securing screws and carefully lifting the table from its two dowel pin locators.

The crystal specimen to be sawn is first X - rayed to find the approximate location of the desired orientation. It is then mounted on to the work table such that the desired orientation is perpendicular to the direction of the cut. This ensures that when the crystal is accurately aligned the rotational limits of the goniometer are not exceeded. If possible, the sample should be mounted within about 20 degrees of the desired orientation.

The specimen is not normally mounted directly on to the work table if slices completely through the material are to made. This is to avoid damaging either the blade, by clogging with the soft material of which the table is made, or the work table with each cut. In general, a base material of glass, or wood, about 4 mm thick, is used placed between the specimen and the work table. These materials will cause no damage to the blade, but on no account should soft metals, such as aluminium or brass, be used as these will rapidly clog the blade and impair the cutting action.

The base material is normally secured to the work table using the same wax or resin as is used to secure the crystal. It may, if desired, be secured seperately with an epoxy resin even if the crystal is mounted using a low melting point wax. This has the advantage of enabling the specimen to be removed seperately without disturbing the base material.

The mounting medium must be compatible with the specimen being cut and with the cutting lubricant used. Usually either a hot setting wax or a cold setting solvent soluble system is used.

1. Hot Melting Wax Mounting System

Suitable waxes for this use are ;-

TANWAX	Available from Metals Research. Working rang of 90 to 105 'C.
SPECIAL MOUNTING COMPOUND	Available from Metals Research. Working ran of 70 to 85 'C.

The work table is first heated, on a hot plate, in an oven or under an infra red lamp, until a film of the selected wax can be melted on its surface.

The base material is then placed on top of this film and a further layer of wax melted on top of this. The specimen, pre warmed to avoid thermal shock, is then placed above this layer and a further quantity of wax is melted over it to give a final thickness of at least 2 mm over the whole surface of the specimen.

The heating source is then removed and the whole allowed to cool until quite hard.

It is important that the wax is securely adhering to the whole surface of the specimen to avoid chipping or cracking. This is particularly so where the specimen meets the blade.

With delicate specimens it may be necessary to provide further support at the sides by placing small pieces of glass along each side and filling all the gaps with more wax.

Some extremely delicate materials, of very high brittleness such as lead telluride (PbTe) or indium arsenide (InAs), if being sliced to less than about 600 micro thickness may need each individual slice to be supported on its free face during cutting.

A technique for achieving this is shown below :-

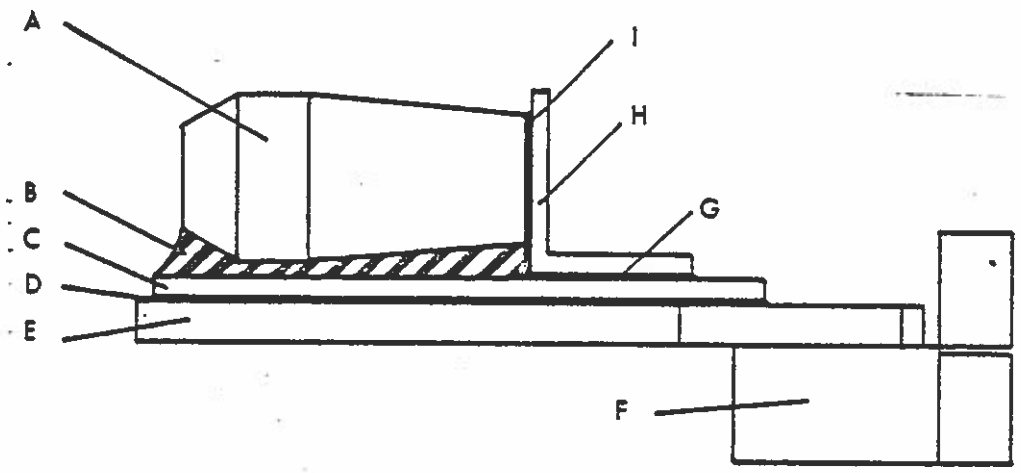


FIG. 14

Ingot Mounted for Cutting with Angle Plate Support

A : Ingot
B : Wax or Resin Coating and Filling Securing Ingot
C : Glass Base Material
D : Wax or Resin Securing Base Material
E : Worktable
F : Standard Adjustable Worktable
G : Low Melting Point Wax Securing Angle to Glass Base
H : Copper Angle
I : Low Melting Point Wax Securing Angle to Face of Ingot to be Sawn

A suitably dimensioned piece of right angle Aluminium plate is secured to the free side of the slice to be cut from the specimen and to the glass base material using a low melting point wax such as glycol pthalate which has a wide melting range.

The specimen is then bonded to the base material in the usual way.

This arrangement allows the Aluminium angle to be removed after each slice has been cut by the gentle heat application from a soldering iron, without disturbing the remainder of the specimen.

As the Aluminium angle will require reaffixing before the next slice is cu the lubricant flow from the machine should be switched off and the specimen and work table degreased preferably using an aerosol degreasant

If a heat sensitive material has to be cut by this method, the angle plate may be secured to the face of the specimen by a suitable solvent soluble adhesive system, or even by using a layer of thick grease as a temporary non setting adhesive.

2. Cold Setting Adhesive Systems

Examples of suitable systems for this application are ;-

Polyester Resins, glass or slate filled, removable with dichlorometh

Acrolyte (Perspex or polymethyl acrylate) removable with chloro

Proprietry solvent soluble systems which may or may not use a filler shoul be found to be satisfactory providing that they are compatible with the material being cut and with the cutting lubricant. The filler used should be inert, powdered graphite, wood flour, powdered glass or slate all beir suitable.

The specimen is mounted using these materials in a similar way to that described for the hot melting waxes except that no heat is required.

When demounting the specimen, the whole assembly is normally immersed in the solvent, which must be compatible with the material being cut. It may also be necessary to agitate the solvent to speed up the demounting process. Often the mounting compound is not actually dissolved by the solvent but only softened. In these cases, the compound may be scraped with a knife and it is often possible to peel it from the specimen cleanly

NB Great care must be taken, whichever system is used, that the screw holes or dowel pin holes in the work table are not filled with the mounting wax or medium, as this will make it impossible to refit the table to the goniometer.

Orienting - A Typical Procedure

Secure the work table back on to the goniometer body and fully tighten the two securing screws.

Position the specimen on to a square Laue post for X - raying.

Take a picture with the goniometer at zero in both the horizontal and vertical axes. Plot the Laue graph.

Rotate the horizontal axis until the point of interest lies in the plane of the goniometer vertical axis.

Take another picture to confirm this and adjust if necessary until it lies exactly in the plane.

Rotate the vertical axis until the point of interest lies exactly in the plane of the goniometer horizontal axis in the same way.

Replace the goniometer on to the goniometer support arm on the Microslice 2 saw and lock it into the correct position for cutting.

If the correct cutting conditions are not known, it is always best to start with a low blade speed (eg about 100 rpm) and a small cutting pressure (eg about 50 gm per cm diameter). Both may then be gradually increased if it is found to be necessary.

After the first cut, the off cut should be removed and checked for orientation accuracy.

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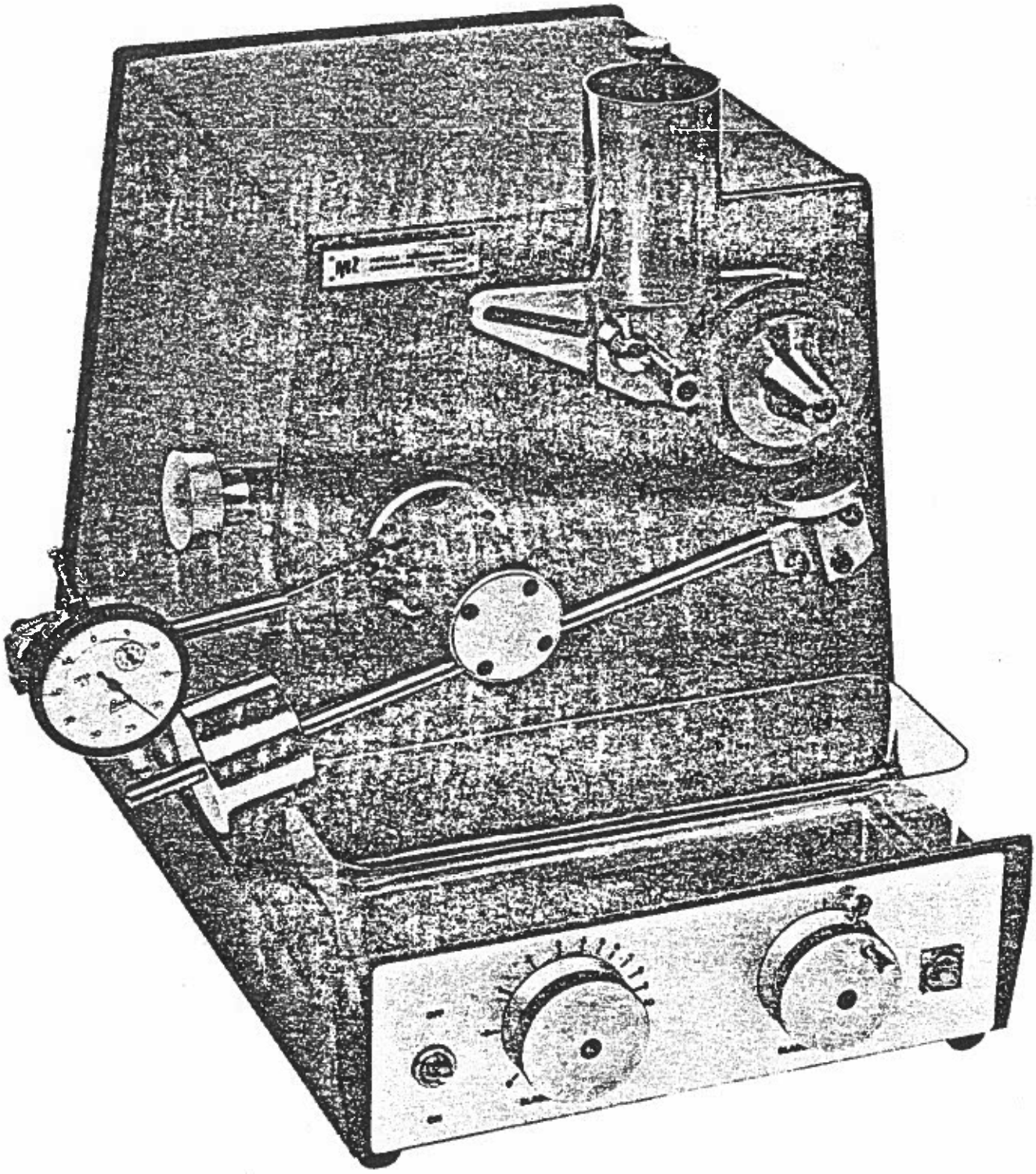
Macrotome 2 Precision Saw



Specification

MACROTOME 2

Spindle Speed	Infinitely variable 50–1200 r.p.m. by calibrated dial
Saw Blades	75mm, 100mm, 125mm and 150mm diameter by 12.52mm bore (detailed list of diamond and Carborundum blades available upon request)
Multiple Blades	20mm space available: number of blades depends upon blade and spacer thicknesses
Cutting Pressure	Variable 5–600gm by adjustable counterweight system
Maximum Depth of cut	75mm blade - 12.5mm. 100mm blade - 25 mm. 125mm blade - 37.5mm. 150mm blade - 50 mm.
Maximum Length of cut (with longitudinal slide)	150 mm.
Thinnest cut possible	See table on page 19
Table cross feed	Blade moves 50mm by micrometer head graduated in 0.01mm divisions
Motor	24 V d.c. shunt wound 1/10 HP
Power Supplies	110/200–250 V, 50/60 Hz, single phase
Weight	23 Kg (50lb)
Overall size	Height 330mm (13 in), Width 280mm (11 in), Depth 380mm (15 in)

Electrical Connections

Set the arrow on the voltage selector to point to the voltage of the supply.

The voltage selector is located on a panel at the rear of Macrotome I and underneath the bottom panel on Macrotome II (this must be removed by unscrewing 6 Allen screws)

Connect the Macrotome to the supply using the conventional

E = ground

L = live

N = neutral

on the input connector provided.

Both Macrotome models have an on/off mains supply switch located on their control panels. Down is on.

Description

The Macrotome 2 is a precision slicing device working on the principle of a carefully counterbalanced 'see-saw' device.

A precision slicing blade of diamond or carborundum is rotated on an accurately machined shaft at a relatively slow controlled speed of between <50 and 1,200 r.p.m. dependent on the nature of the workpiece. The workpiece is fed into the wheel by the damped counterbalanced see-saw. The damping is arranged to give the system a low effective inertial mass and the counterweight is chosen to give the appropriate feed pressure. This principle allows the work to back away automatically if the blade encounters a hard spot or surface protusion or if there is a peripheral variation in the saw blade. This avoids excessive mechanical and thermal stresses that could be imposed on the workpiece if the feed was uniform and unyielding.

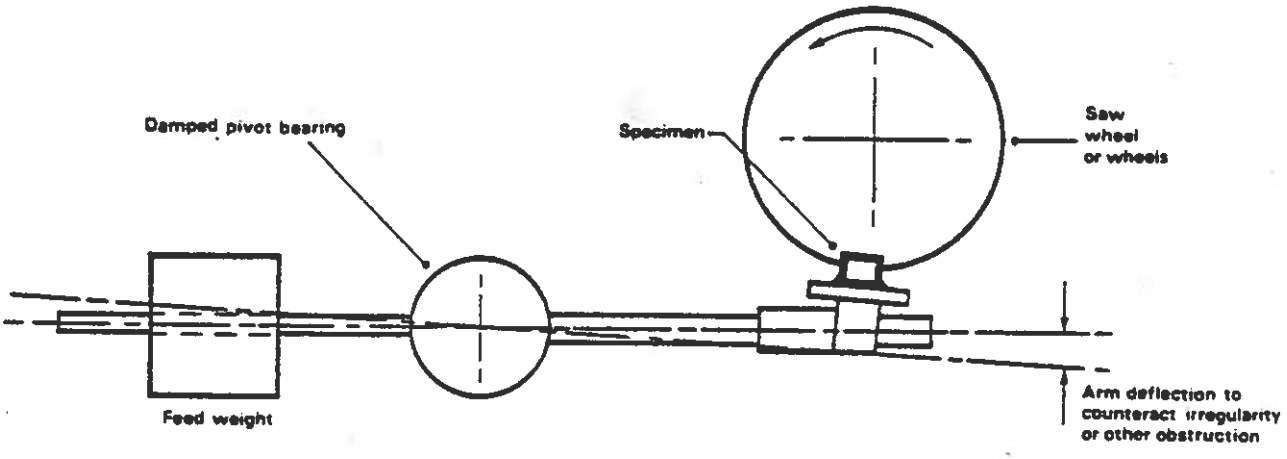


Fig. 1. Peripheral slow speed sawing principle.

The Macrotome 2 has provision for cutting long specimens by the use of a longitudinal slide assembly and also provision for ganging up to fifty blades for multiple slicing and dicing.

Available Accessories

4432	Rotary Divided Table for slicing in one plane
4433	Precision Goniometer Table for use with X-ray orientation facilities and designed to be interchangeable
4434	'V' Block Table to which cylindrical specimens may be clamped without wax or resin mounting
4435	Dial Gauge Attachment
4436	Stainless Steel Check Plates 50 mm (2in) diameter
4437	Stainless Steel Check Plates 75 mm (3 in) diameter
4438	Stainless Steel Check Plates 100 mm (4 in) diameter
4440	Multi-Plunge Feed Attachment for cutting long, thick specimens

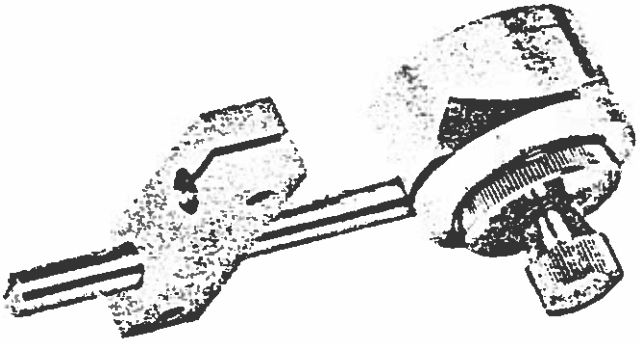


Fig. 2. Multi Plunge Feed Attachment.

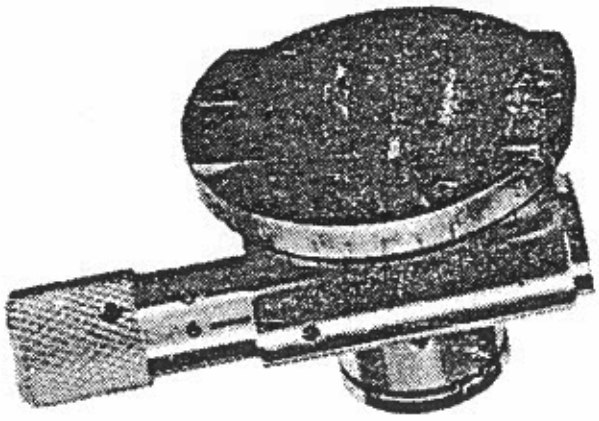


Fig. 3. Rotary Divided Table.

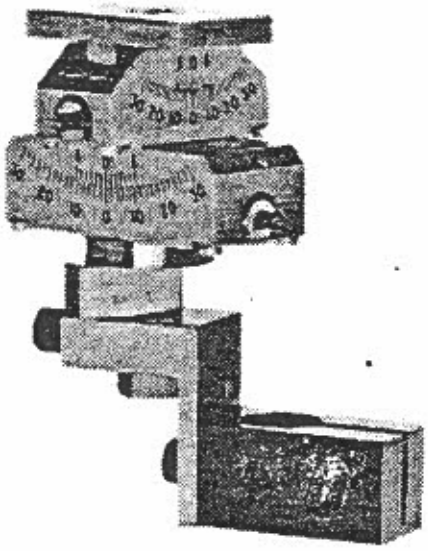


Fig. 4. Goniometer.

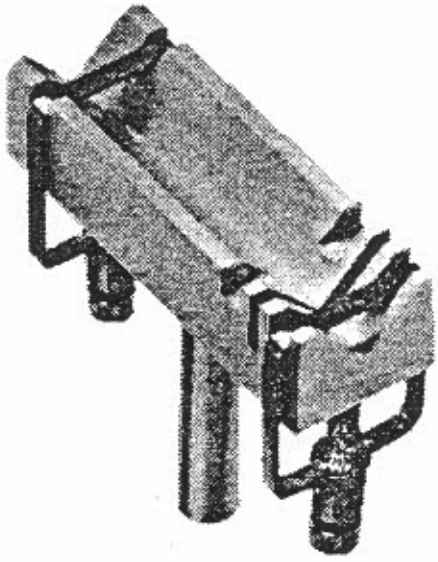


Fig. 5. V Block Table with screw clamps.

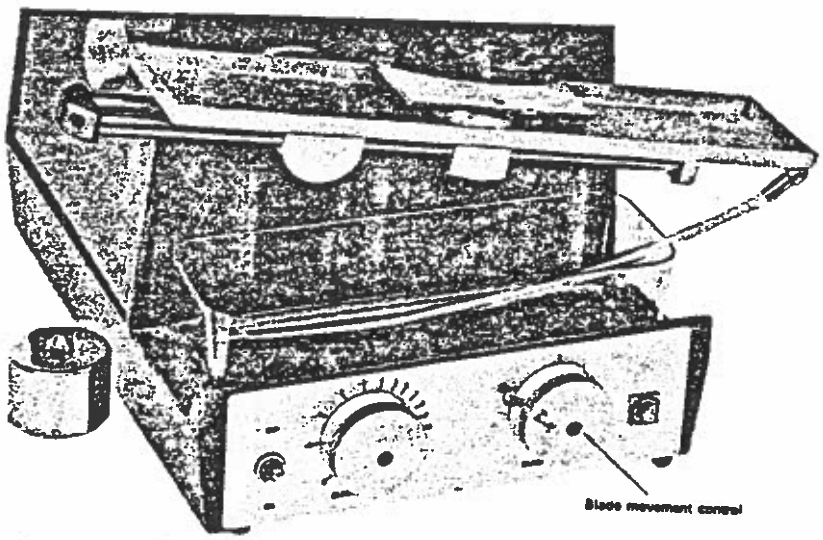


Fig. 6. Sliding Table for Macrotome.

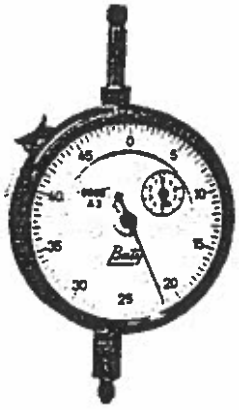


Fig. 7. Dial gauge attachment.

Operation

The procedure for setting up the Macrotome starts with selecting the type of table most appropriate to the work

USE OF THE SEE-SAW SWING ARM

The swing arm should be attached as follows (fig. 8)

Insert the pivot shaft 'A' through the rotation stop 'C' and into the hole 'B' and lock in position by clamp. The pivot action must now be locked by clamp 'D' such that the swing arm will not move upwards to damage the blade.

To attach the blade to the spindle on Macrotome 2, first remove the Allen screw from the locking ring, the locking ring itself and the cheek plate. Having cleaned the appropriate blade and the plates, re-assemble on to the spindle in the order shown. The recess in the cheek plate goes next to the blade so that clamping takes place only around the periphery.

The lubricant holder can now be positioned to produce a capilliary flow between the blade and the ptfe ring as shown in fig. 10.

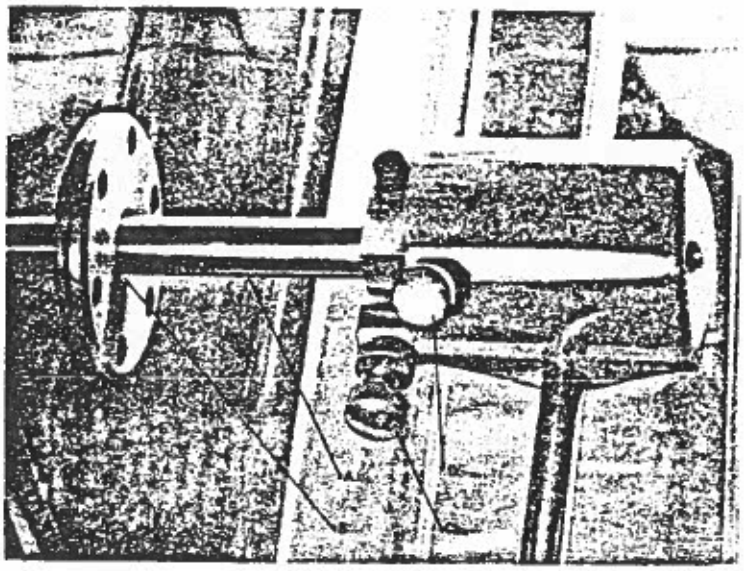


Fig. 8. Fixing see saw swing arm.

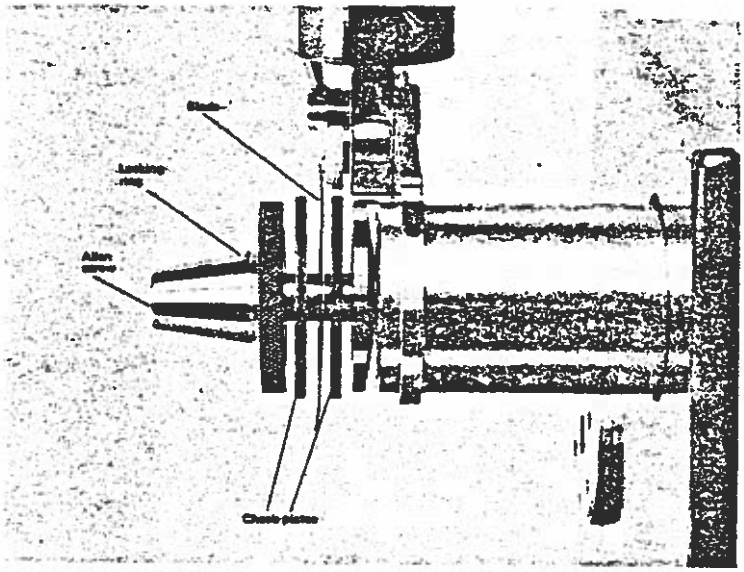


Fig. 9. Arrangement of check plates and blade.

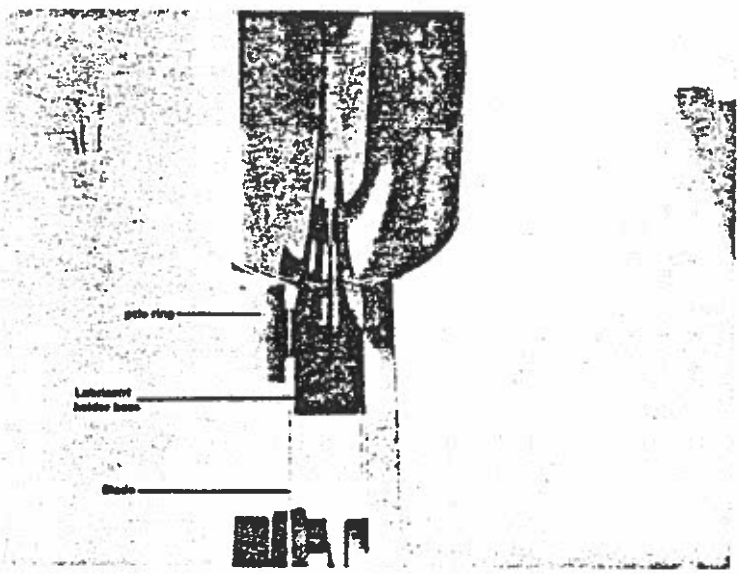


Fig. 10. Positioning of blade.

The sample to be cut is mounted on the appropriate table wh ich is then attached to the swing arm by means of a universal clamp (fig. 11). The position of the work table is adjusted so that the table forms a tangent to the blade, i.e. the specimen will pass through the centre of the blade. The rotation stop should be adjusted to give the requisite depth of cut, i.e. so that the blade passes through the specimen but does not damage the cutting table. Care must be taken while these adjustments are being carried out so that the blade is not damaged in any way.

The correct weight should now be selected (from the three provided) so that when it is positioned on the arm, with clamp D released, it just balances the specimen and table. If the weight is now moved away from the pivot the specimen will impart a load on to the blade. This load, which can be varied by re-positioning the weight, will depend upon the nature of the specimen and the desirable rate of cutting (see application section).

The Macrotome can now be switched on, the correct speed selected and the flow of lubricant regulated. The swing arm should be supported, and the sample allowed to come gently into contact with the blade. Once cutting has commenced the arm can be completely released and the blade will cut through the sample at its own rate (as described in the section on the Macrotome principle on page 4).

After cutting, the machine can be switched off and the pivot arm with specimen attached must be rotated away from the blade, and the pivot action locked. The flow of lubricant can then be stopped.

To produce a parallel cut the blade can be moved over in increments of 0.01 mm by means of the control at the front of the machine, fig. 6. The previous procedure is repeated to commence cutting.

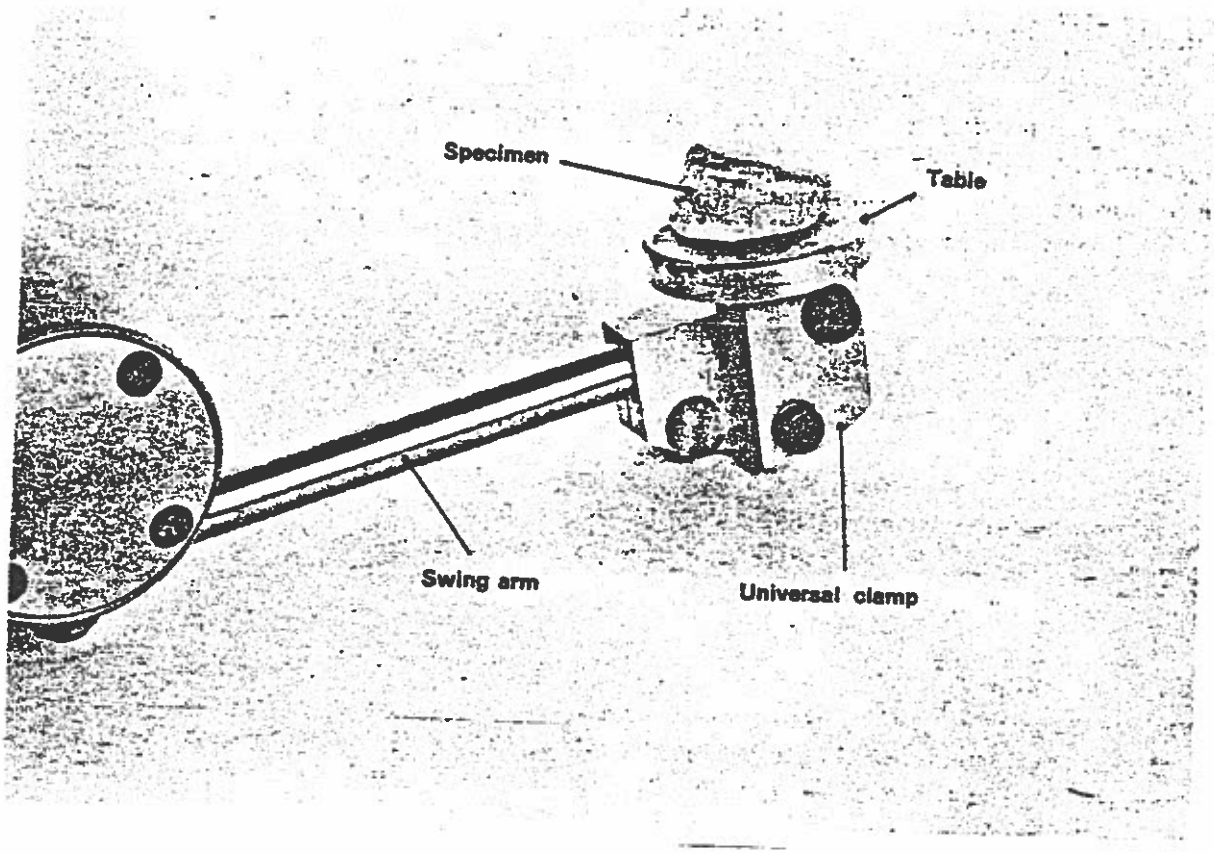


Fig. 11. Fixing table to arm.

USE OF THE ROTARY DIVIDED TABLE

If the Rotary Divided Table (fig. 3) is being used, this is attached to the swing arm of the Macrotome by means of the clamp on its base. After making the first cut the table can be rotated through the required angle in increments of 1° and the next cut made. The previous procedure for commencing cutting is repeated.

USE OF THE GONIOMETER

The Goniometer comes complete with attachments so that it may be transferred from an x-ray machine to the Macrotome 2 without loss of orientation of the crystal to be cut.

The Goniometer head, (fig. 12;A) consists of two worm drivers concentric dovetailed arcs positioned at right angles to each other in the horizontal plane, rotatable about their common vertical axis. Rotation of the worltable, B, about the horizontal axes is by means of the socket key, C, provided the arc scales being in degrees, with vernier resolution of ten minutes.

The alignment of the vertical axis of the Goniometer is determined by the square base peg, D. If this axis is aligned parallel to the plane of the saw-blade, and perpendicular to the axis of the x-ray beam, a crystal mounted on the worktable may be oriented using standard Laué techniques to bring the required crystallographic axis either perpendicular or parallel to the x-ray beam and hence into a known relationship with the Goniometer vertical axis and the cutting plane of the Macrotome 2.

The jigs E,F and G,H and K are used to produce this alignment. The Goniometer arcs are both set to zero and the base peg, D, inserted into hole J in H and screw 6 tightened. G,H and the Goniometer are assembled to the Macrotome 2 swing arm as shown in fig. 13. Jig K is attached to the blade spindle as shown, and G is rotated about the swing arm and H about G via screw 2 to bring the alignment face L, of K, and the worktable face, B, into exact parallelism. Screws 1 and 2 are now tightened, and the vertical axis of the Goniometer is now set parallel to the cutting plane. Note that rotation of H about G (screw 2) will not affect this alignment, but screw 1 must not be released.

The Goniometer may now be transferred to hole I in jig F and clamped by screw 4. Part E must be attached to a post on the x-ray table and aligned so that its long axis is parallel to the x-ray beam in the horizontal plane. F may now be rotated with respect to E to bring the vertical axis of the Goniometer perpendicular to the x-ray beam and clamped by screw 3. The crystal may now be mounted on the worktable directly, or preferably via a glass slide, and aligned tothe x-ray beam by means of the two Goniometer arcs and rotation about the vertical Goniometer axis,which may be clamped by screw 5.

The required crystallographic axis will now be oriented with respect to the Goniometer base D and may now be transferred, without loss of orientation, to the hole J in part H on the Macrotome 2. The required cut, perpendicular or parallel to the crystal axis may now be made.

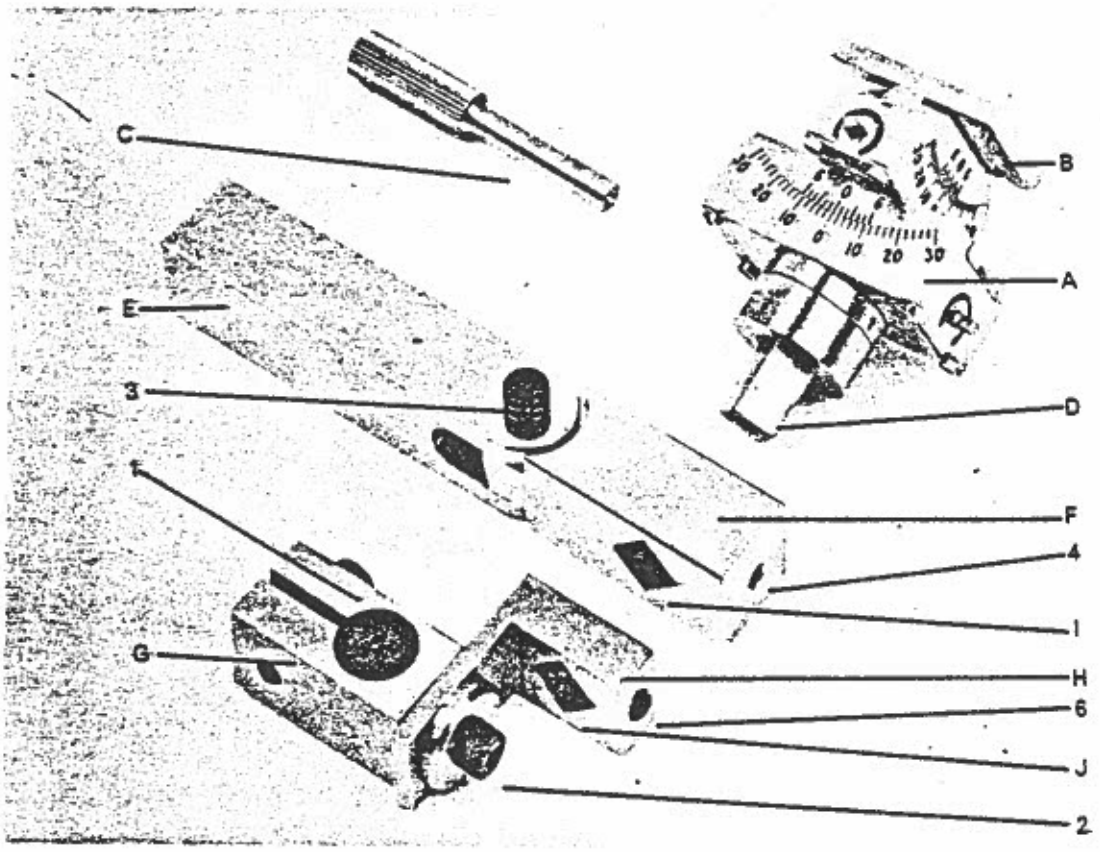


Fig. 12 Goniometer head

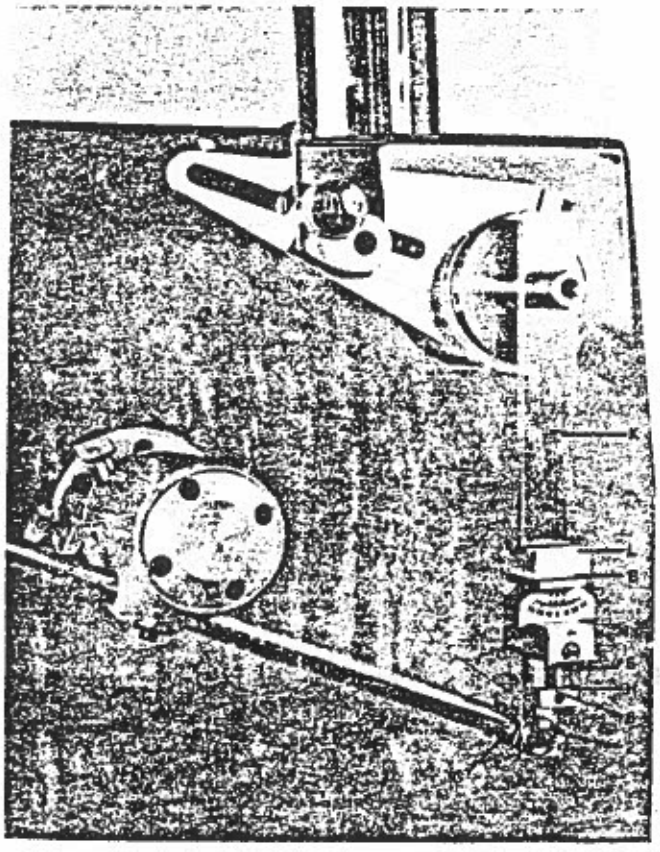


Fig. 13 'Z' arm arrangement for goniometer—Macrotome I

USE OF THE VEE BLOCK ASSEMBLY.

A vee block assembly is available for cutting long specimens which require supporting along their length.

Attachment of the vee block to the swing arm is by means of the universal clamp. Specimens are mounted on the vee block using the screw clips provided and the previous procedure for commencing cutting is repeated.

USE OF THE SLIDING TABLE

The sliding table is mounted on the machine in place of the swing arm attachment. A s shown in diagram fig. 15. it is located in the pivot hole and locked into position as with the swing arm attachment.

Specimens are mounted on a special table which locates on the sliding tray. This positive fixing is by means of a ball fixing which locates into a groove. There are two grooves on the fixture on the sliding tray so that the table can be rotated accurately through 90°. The sliding carriage is mounted with low friction bearings onto a track, and by attaching a suitable weight at the end it can be drawn along towards the blade but still maintaining a non-positive feed.

The angle of the table is adjusted by the pivot lock so that the blade can traverse the table and just cut through the specimen but not into the table (as in fig.16.)

The rate of feed of the table can be adjusted by turning the knurled locking screw underneath it.

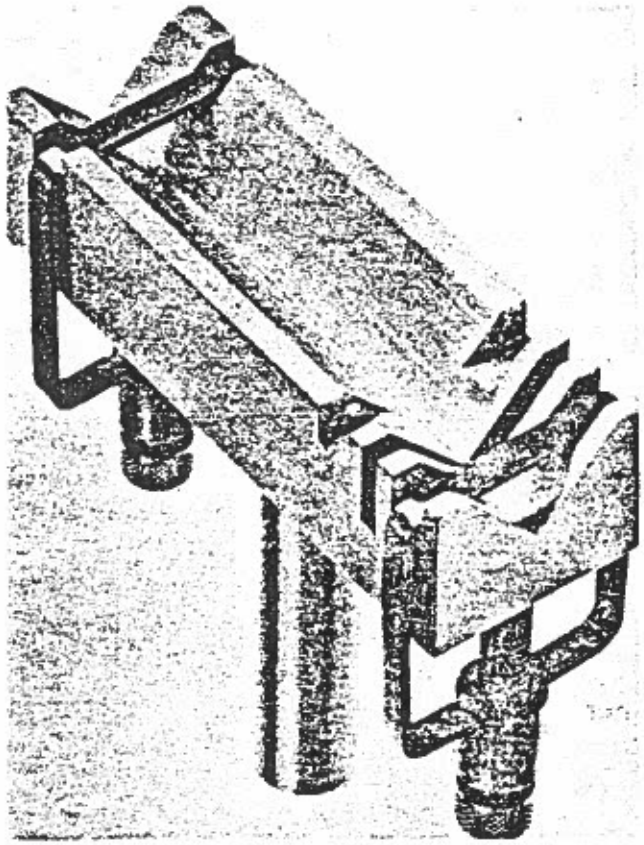


Fig. 14 V Block and clamp screws

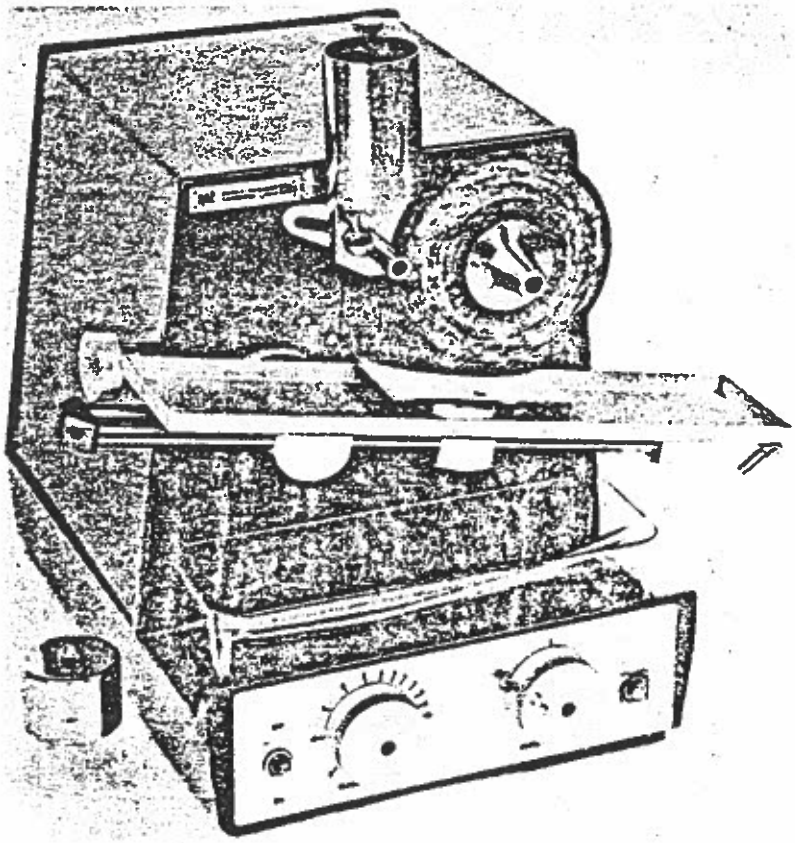


Fig. 15. Longitudinal Slide on Macrotome 2.

MULTI-BLADE SAWING.

It is possible with Macrotome 2 to gang several blades together on the main spindle with a spacer between each pair, such that a series of cuts can be made in one operation. The standard Macrotome 2 will allow up to about six blades to be used at once, depending on the thickness of the spacing collars used. The Macrotome 2 model with the extended spindle will take up to fifty blades at once.

The spacing collars can be made from ferrous or non-ferrous flat strip, but care must be taken to ensure that there is no edge turn over or burring. The thickness of the spacing collars will depend on the required size of the cut sample. It is possible to produce specimens 125 microns in thickness.

It is sometimes necessary to true the discs after mounting on the cutting spindle, because the bores vary slightly in diameter and this could result in an uneven saw load. If a 14 microns diamond lap is pressed lightly against the rotating blades with a dial test indicator monitoring the movement of the work table, the trueing treatment can be stopped, when the dial test indicator shows no movement.

To avoid initial damage, the blades are started from rest in contact with the sample. The speed is then gradually increased to the required rate.

Lubricant is supplied by a special applicator so that all the blades are lubricated. This type of applicator is supplied with all Macrotome 2 models, and can be attached by unscrewing the Allen screw of the normal lubricator and removing it. The long applicator is screwed on in its place.

This method of cutting can be used with the conventional plunge technique (i.e. the specimen mounted on a simple compound table on the swing arm and allowed to feed into the saw disc), or with the sliding table if long cuts are required.

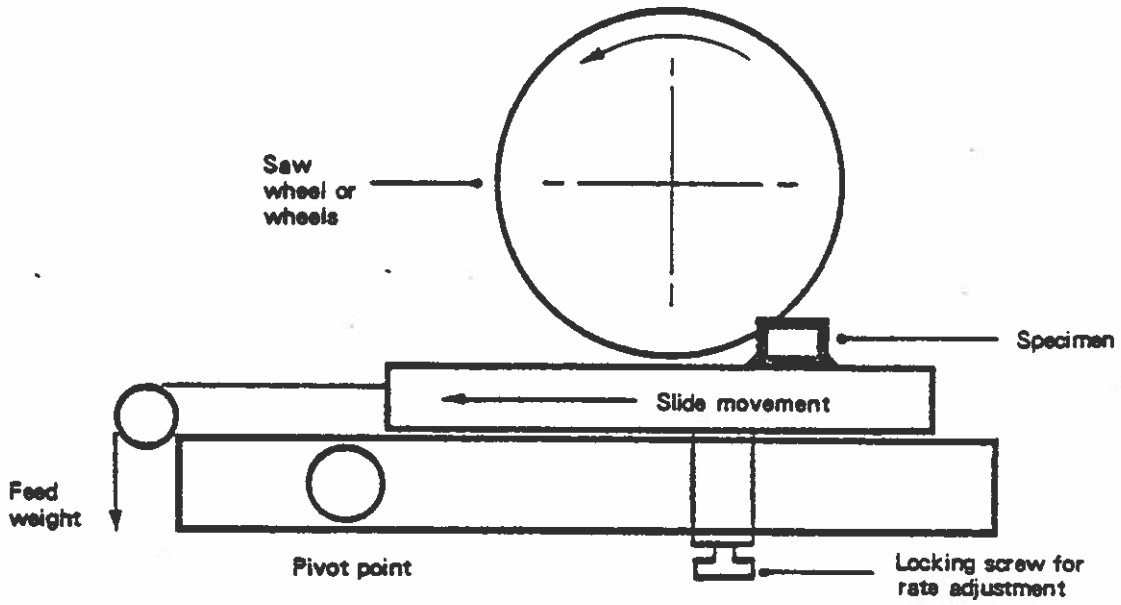


Fig. 16. The Longitudinal Slide Principle.

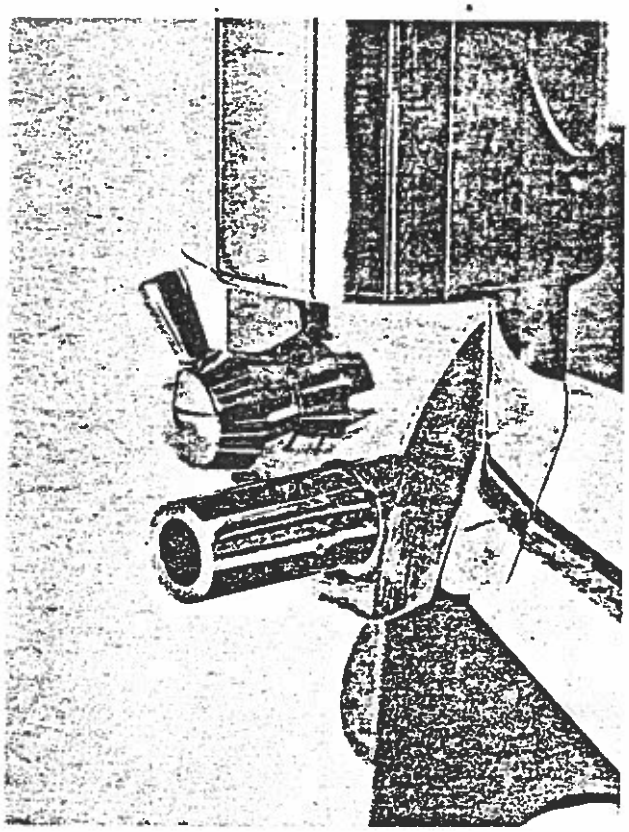


Fig. 17 Lubricator feed for multi blade sawing

SPECIMEN MOUNTING.

For simple cutting without using the longitudinal slide attachment the workpiece is attached to a piece of glass (e.g. a microscope slide) by a suitable compatible adhesive. The glass is then fastened to the work table by double sided adhesive tape or any other conventional adhesive. When very thin slices are to be cut it; may be necessary to encapsulate the specimen completely to eliminate movement. Backing plates,cover slips or thin glass slides can be used to give the necessary support to very delicate or multi constituent materials.

Delicate cylindrical specimens may be first mounted in a plastic or glass cylinder of suitable diameter and then composite workpiece can be cut.

When using the longitudinal slide assembly, the specimen should be mounted more rigidly to prevent movement during long cuts.

Using the multiple blades for materials other than semiconductors, conventional adhesion methods are used. It is often advisable to cover the specimen with a layer of lacquer or wax to prevent chipping. When dicing semiconductors, the specimen should be mounted on a soft but firm material (e.g. carbon, perspex, Tufnol or methyl methacrylate) and lacquer should be applied over the top of the specimen before making the second cut at 90°.

Precautionary Notes

1) The quality of saw cut produced will always depend upon the quality of the blade, the correct loading and correct speed. It is inadvisable to use a damaged blade as the quality of the cut will inevitably be degraded.

Damage occurs in two ways:

a) by chipping the blade due to bad handling
b) by twisting the blade due to excess pressure being exerted.

Thus it is extremely important to prevent knocking the blade with the swing arm or specimen, or allowing the blade to seize up in the specimen due to excess loading.

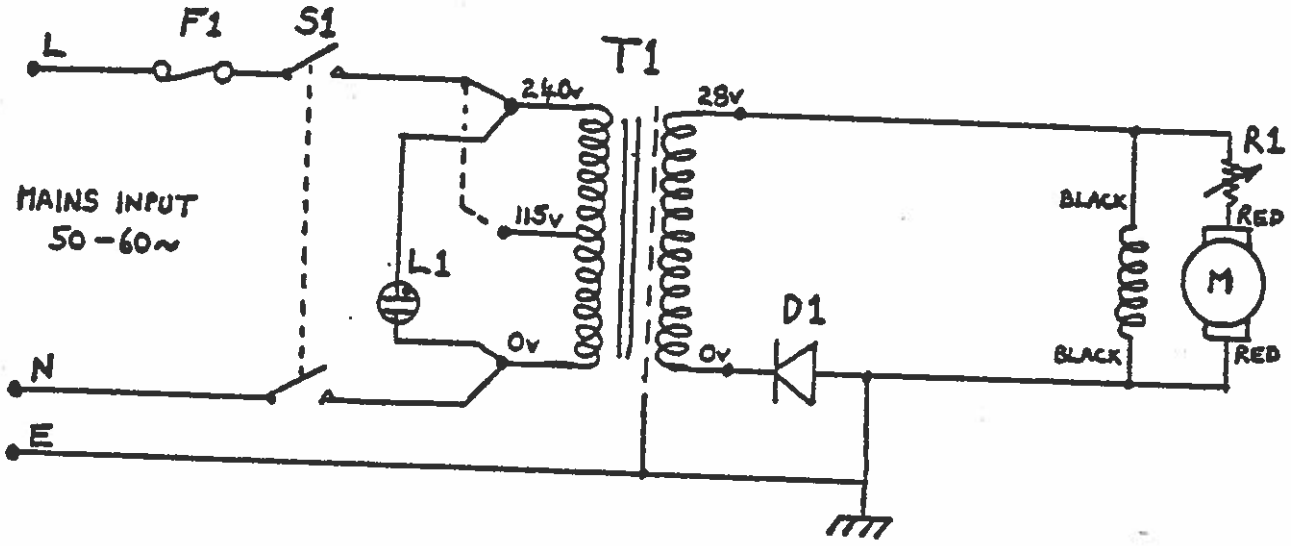
2) Damage can easily be caused to specimens which are not rigidly mounted, especially if the longitudinal sliding table assembly is being used.

3) It is often necessary to "dress" the saw blade by lightly holding a piece of alumina or similar material against it. This is always necessary when cutting plastics which might clog the blade and lead to seizure.

Examples of materials cut on the Macrotome

Material Cut	Type of Blade	Diameter & Width of blade (mm)	Thinnest Section obtained	Grit size.	Cutting (r.p.m.)	Pressure (grms)	Depth of cut (mm)	Time (mins)
Indium Antimonide	Sintered and Electrometallic	100 x 0.3.		170 280	250–300	20–30	20	10
" "	" "	75 x 0.25.		280 400	50 100	5	0.05	2
Germanium	Sintered	100 x 0.3.		170	250–300	20–30	6	5
Ruby/Sapphire	Sintered and Electrometallic	125 x 0.4. 100 x 0.3.	.1mm	160 280	100–400	350	20	20
Calcium Fluoride	Sintered and Electrometallic	125 x 0.4. 100 x 0.3.		160 280	50–200	60	35	10
Calcium Tungstate	Sintered	100 x 0.3.		170	100	30	2	5
Neodymium doped Glass	Sintered	100 x 0.3.		170	200	30	12	2
Vanadium Germanium Alloy	Sintered	100 x 0.3.		170	100	40	5	5
Uranium Carbide	Electrometallic	75 x 0.25.	.1mm	400	200	10	3	3
Lanthanum bi-Fluoride	"	100 x 0.3.		280	150	25	18	4
Yttrium-Aluminium Garnet.	Sintered and Electrometallic	100 x 0.3.		170 280	100–400	250	10	4
Calcium Molybdate	Electrometallic	100 x 0.3.		280	150–250	25	10	5
KDP	Electrometallic	100 x 0.3.		280	150–250	10	10	10
High Alumina Ceramics	Sintered	75 x 0.25.	.05mm	300	200	60	0.5.	2
Tungsten	Sintered	100 x 0.3.	.25mm	170	150	250	6	20
Anthracene Trans-Stilbene	Sintered and Electrometallic	100 x 0.3.		170 280	100	10	12	5
Quartz	Sintered	100 x 0.3.		170	200	250	6	1
Strontium Titanate	Sintered	100 x 0.3.		170	200–250	200	12	10

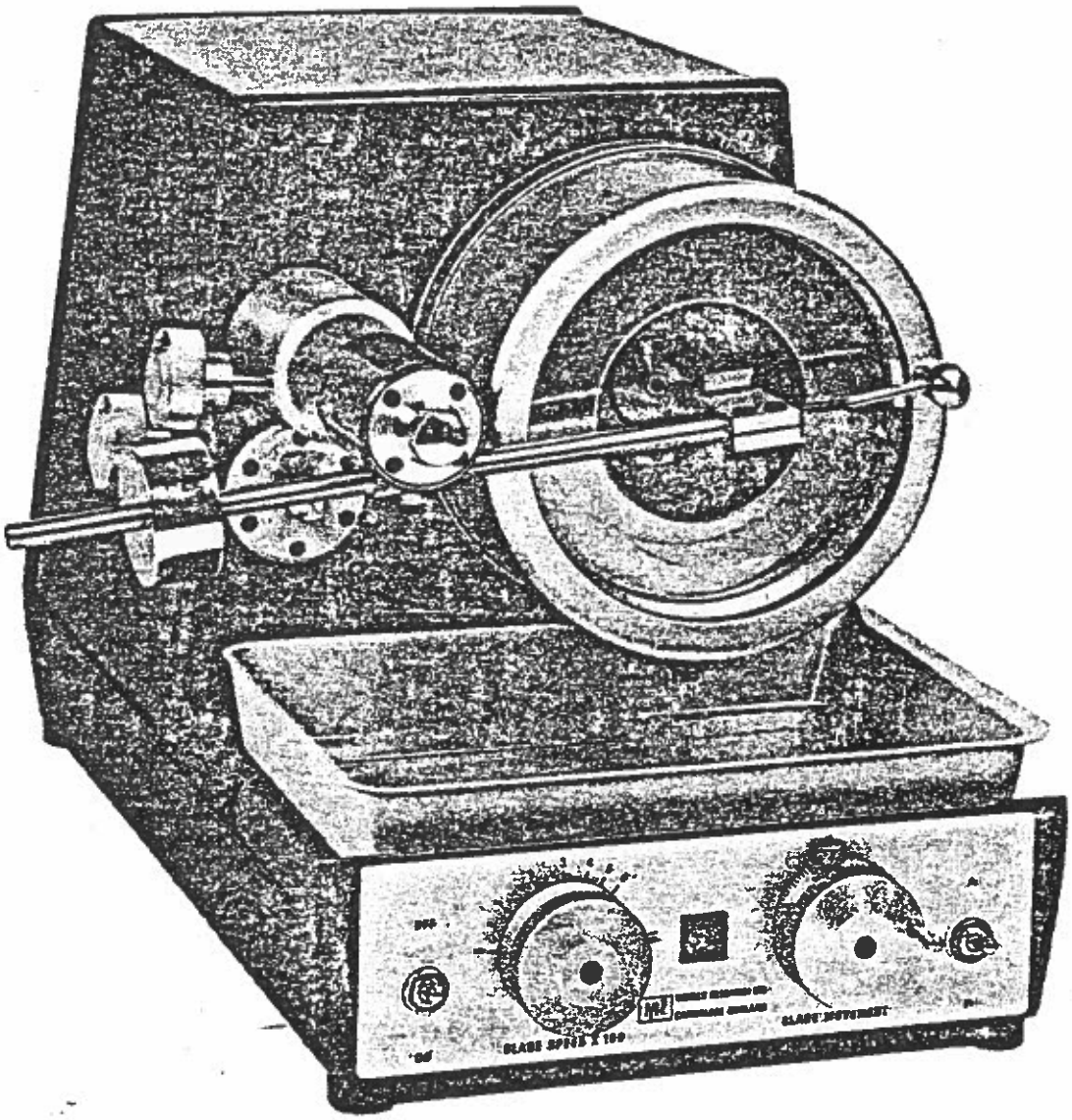
Material Cut	Type of Blade	Diameter & Width of blade (mm)	Thinnest Section obtained	Grit size.	Cutting (r.p.m.)	Pressure (grms)	Depth of cut (mm)	Time (mins)
Bone	Sintered	100 x 0.3.	.1mm	170	200	100	12	10
Plastics	Sintered	125 x 0.9.	.1mm	170	300	80	25	20
Granite	Sintered	75 x 0.25.		300	200	60	0.5.	2
Bone (encapsulated)	Sintered	100 x 0.3.	.1mm	220	500–600	100	25	60
Arteries (encapsulated)	Sintered	100 x 0.3.	.1mm	220	400–500	50	12	30
Teeth (encapsulated)	Sintered	100 x 0.3.	.25mm	220	100	50–75	25	60
Wood Cores	Electrometallic	75 x 0.3.	1.0mm	150	150–200	100	10 x 150	15
Silica Glass Plate	Sintered	100 x 0.3.	.25mm	220	600–700	150	8 x 125	20
Rock	Sintered	125 x 0.4.	.25mm	220	650	75	25	45
Glass Fibre	Sintered	100 x 0.3.	.1mm	220	600–700	100	12	10
Carbon Fibres in Bonded Medium	Sintered	75 x 0.25.		220	50	50	50 x 3	10
Gallium Phosphide	Sintered or Carborundum	100 x 0.3. 100 x 0.15.	.25mm	220	100	100	35	15
Gallium Arsenide	Carborundum	75 x 0.15.	.17mm	220	50	20	8 x 5	10
Lithium Ferrite	Sintered	75 x 0.25.	.25mm	220	250	40	10	2
Potassium Lithium Niobate	Sintered	75 x 0.25.		220	75	30	5	1
Barium Titanate	Sintered	75 x 0.25.		220	75	30	5	1
Mild Steel	Sintered	100 x 0.3.	.25mm	220	700	70	10	20
Ferrite	Sintered	75 x 0.25.	.1mm	220	400	40	10	15
Titanium Alloy	Sintered	75 x 0.25.	.5mm	220	600	60	10	10
Boron Carbide	Sintered	75 x 0.25.	.1mm	220	600	250	10	45
Silicon Carbide	Sintered	75 x 0.25.	.1mm	220	600	250	10	45



M	TYPE SD11
T1	TYPE 1278
R1	PX50/12.5 ohm/16F
D1	TYPE 6F10
L1	SGF 1717/220
S1	TYPE 8370/K7
F1	TYPE L1348
Fuse	TYPE L1055-5A

Fig. 18 CIRCUIT DIAGRAM MACROTOME 2

Microslice 2 Dual Purpose Saw



Specification

MICROSLICE 2

Peripheral Configuration - as Macrotome 2

Annular Configuration:

Spindle Speed	Continuously variable 50-1200 r.p.m. by calibrated dial
Saw Blades	175 mm (6.9in) overall diameter with 8.25 mm (3.25 in) internal diameter. Electrometallic diamond cutting surface on inside edge.
Cutting Pressure	Variable 5-600gm by adjustable counterweight system
Max. Depth of Cut	31 mm (1.125 in) using 82.5 mm (3.25 in) internal diameter blades.
Thinnest Slice that can be cut.	Approximately 0.10 mm (0.004 in)
Table Cross Feed	Blade moves 50mm (2 in) by micrometer head graduated in 0.01mm divisions.
Motor	24 V d.c. shunt would 1/10 HP
Power Supplies	110/200-250 V, 50/60 Hz, single phase.
Weight	28 kg (62 lbs)
Overall Size	Height, 330mm (13 in), Width, 280 mm (11 in) Depth, 500 mm (20 in).

Electrical Connections

Set the arrow on the voltage selector to point to the voltage of the supply.

The voltage selector is located on a panel underneath the bottom panel on the Microslice 2 (this must be removed by unscrewing the 6 Allen screws).

Connect the Microslice 2 to the supply using the conventional:

E = ground
L = live
N = neutral

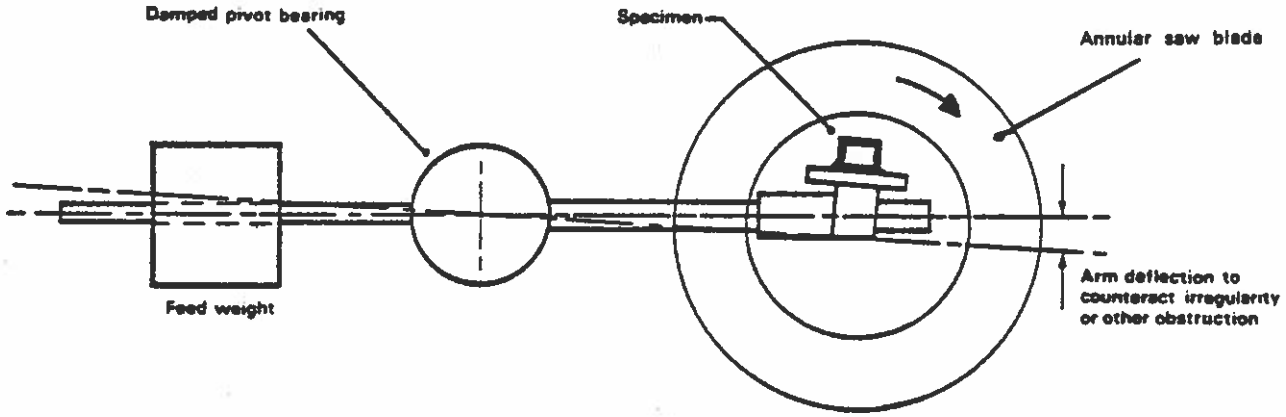
on the input connector provided.

The Microslice 2 has an ON/OFF switch located on the control panel. Down is ON.

Description

The Microslice 2 is a Precision Dual Purpose Saw, working on the principle of a carefully counterbalanced "see-saw". It can be used for Peripheral cutting, in which configuration is in all respects identical to the Macrotome 2, and also for Annular sawing, which offers several advantages over peripheral sawing.

A tensioned annular cutting blade is rotated on an accurately machined shaft at a relatively slow controlled speed of between 50 and 1200 r.p.m., dependent on the nature of the workpiece. The workpiece is fed into the wheel by the damped counterbalanced see-saw. The damping is arranged to give the system a low effective inertial mass and the counterweight is chosen to give the appropriate feed pressure. This principle allows the work to back away automatically if the blade encounters a hard spot or surface protrusion or if there is a peripheral (internal) variation in the saw blade. This avoids excessive mechanical and thermal stresses that could be imposed on the workpiece if the feed was uniform and unyielding.



Since the Annular blade of the Microslice 2 is held in tension from its periphery, it is possible to make it from much thinner material than a normal peripheral cutting disc. This means that the width of each cut is extremely small and also the tensioned blade cannot "wander" through the workpiece as it is cutting.

ACCESSORIES

When used in the peripheral configuration, all of the accessories listed for the Macrotome 2 may be used with the Microslice 2. The longitudinal slide is not supplied with the Microslice 2, but is available under part No. 4439, as an accessory. The Rotary Divided Table, part No 4432, and the 'V' Block Table, 4434, can be used with the Microslice 2, in the annular configuration.

Operation

When delivered, the Microslice 2 will be completely assembled except for the attachment of the lubrication feed, but the Annular saw blade will not have been tensioned. Before using the Microslice 2, the blade must be tensioned or damage will result when the workpiece comes into contact with it. The following relates to the operation of the Microslice 2 in the annular sawing configuration. For use in the peripheral configuration, please refer to the comments on the Macrotome 2, pages 1-22.

ANNULAR BLADE MOUNTING

The blade can be renewed without removing the chuck from the saw spindle. For this, the long screws in the holes marked with the letters A-H are removed and the saw, still in place between its clamping rings, can be taken from the chuck (Fig. 2).

Before mounting the new blade, it should be inspected for damage and rejected if any scratches, dents or pips are to be seen on the surface. The area which will come into contact with the clamping rings (both sides) should be thoroughly clear of any foreign matter, particularly between the clamping teeth and then degreased with a suitable solvent. The lower clamping ring (i.e. the one containing the tapped holes) is then placed plain side downwards on the saw-centering jig (Fig.3). The annular blade is placed in the jig and located centrally by the tapered aligning plug. The upper (counter bored) clamping ring is placed over it in the numbered holes. Final tightening should be carried out with the torgue wrench set at about 400g/metre (35 lbs/in.) It is advisable to carry out this operation sequentially 1,2,3,4 etc. Note that this clamping operation stretches the blade and that its bore will be enlarged. The taper plug should be gently adjusted to minimise uneven stretching.

The rim of the chuck should be smeared lightly with either a molybdenum disulphide grease or some alternative medium pressure lubricant such as an aluminium stearate grease, the clamped assembly placed over it and the eight longer 2BA screws all lightly tightened in the order A,B,C,D,E, etc. Final tightening is carried out with the wrench set at the same value as for the ring. Under these conditions the blade will deflect about 50 microns at a point 3 mm from the cutting edge, for an applied load of typically 200g/0.07cm^2. The bore diameter should be about 83.06mm.

The blade guard cover should be carefully placed over the cutting head. It will be seen that there is a rubber seal (Fig. 4A) on the back plate of the cutting head. The cover is placed over the seal and the three knurled screws tightened. The chromium plated ring can be slid back to the back plate.

The lubrication feed is screwed to the side of the blade guard (fig.5), but great care must be used as the end of the feed pipe can easily damage the blade. The feed pipe is on a hemispherical universal joint so that the flow of lubricant can be directed on to the cutting edge of the blade. Once the position has been adjusted, the knurled knob can be tightened.

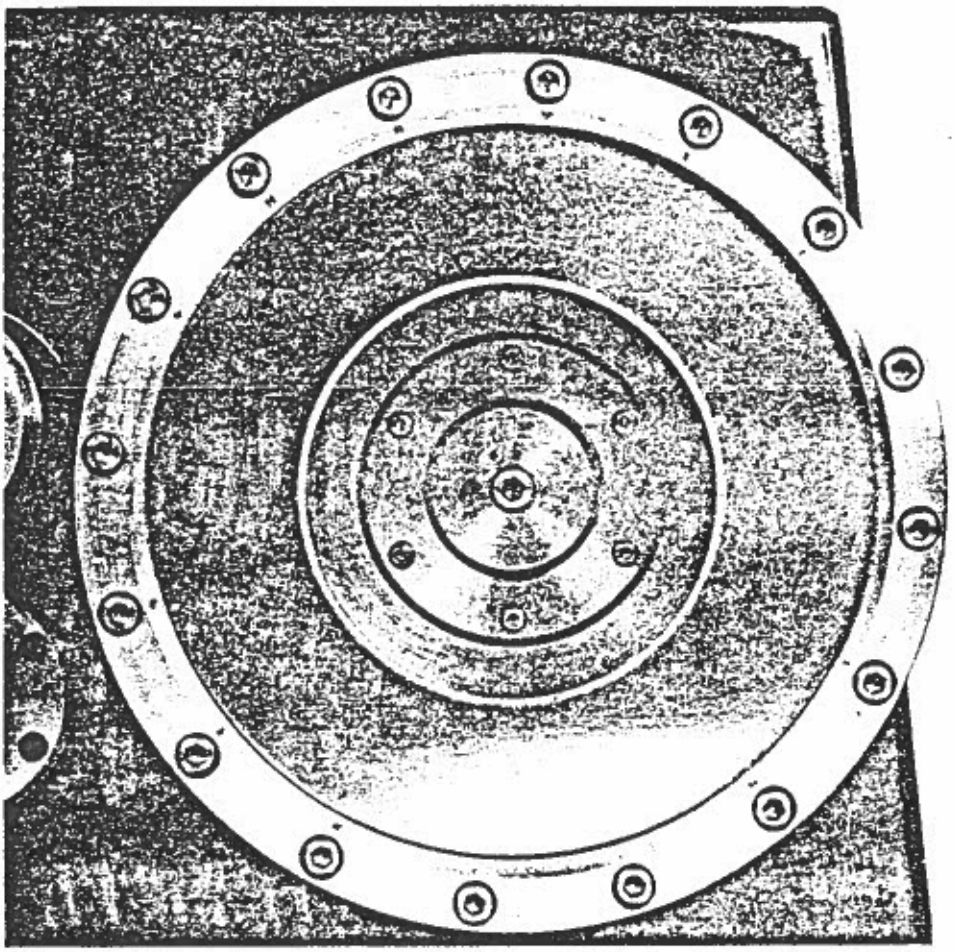


Fig. 2 Mounting annular blade

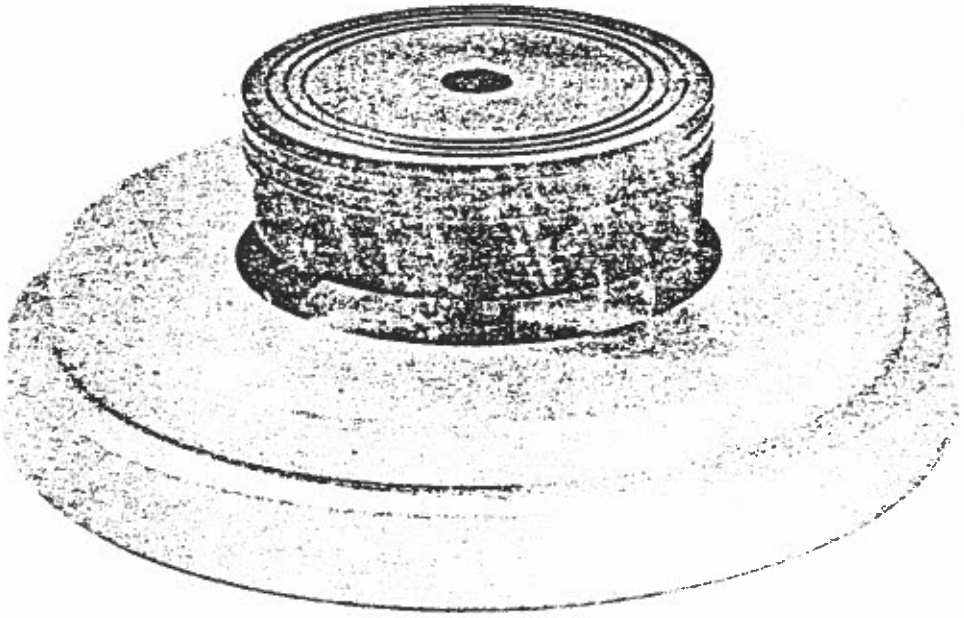


Fig. 3 Saw centering jig

BLADE LIFE

It is not possible to put a positive figure on the life of a blade since this depends on the material cut and the durability of the annular disc itself. Electrometallic annular blades are not recommended for materials with a Moh hardness >8, though relatively short-term success can be obtained at the slow r.p.m. used.

The smaller mesh diamond sizes (circa 300), though giving the finer finishes and lowest kerf losses, do not last as long as blades with 240 grit. When monitoring of the cut slices shows that these are beginning to exhibit undulations or wedging, then it is almost certainly the sign of an ageing blade. The fact that one blade has been found to cut hundreds of slices before renewal is not a safe guide to the life of the next identical blade, operating identically. The best indication is gained from sampling the slices cut.

LUBRICANT

The lubricant is recirculated on the Microslice 2. If the lubricant is poured into the level of the cutting edge of the blade, it will be found that very little is lost from the system. A tray is provided to catch any slight splash or drips which may occur. It is advisable to replace the lubricant regularly since particles suspended in it will tend to force any of the slices being cut away from the main bulk of material and thus affect the slice thickness.

The lubricant can be released by unscrewing the drain plug mounted at the bottom of the blade guard (fig.5). The cutting head itself has four drain holes in it and one of these must be turned to the bottom position to release the lubricant. If corrosive lubricants are used, it is advisable to dismantle the cutting head and clean each of the parts separately.

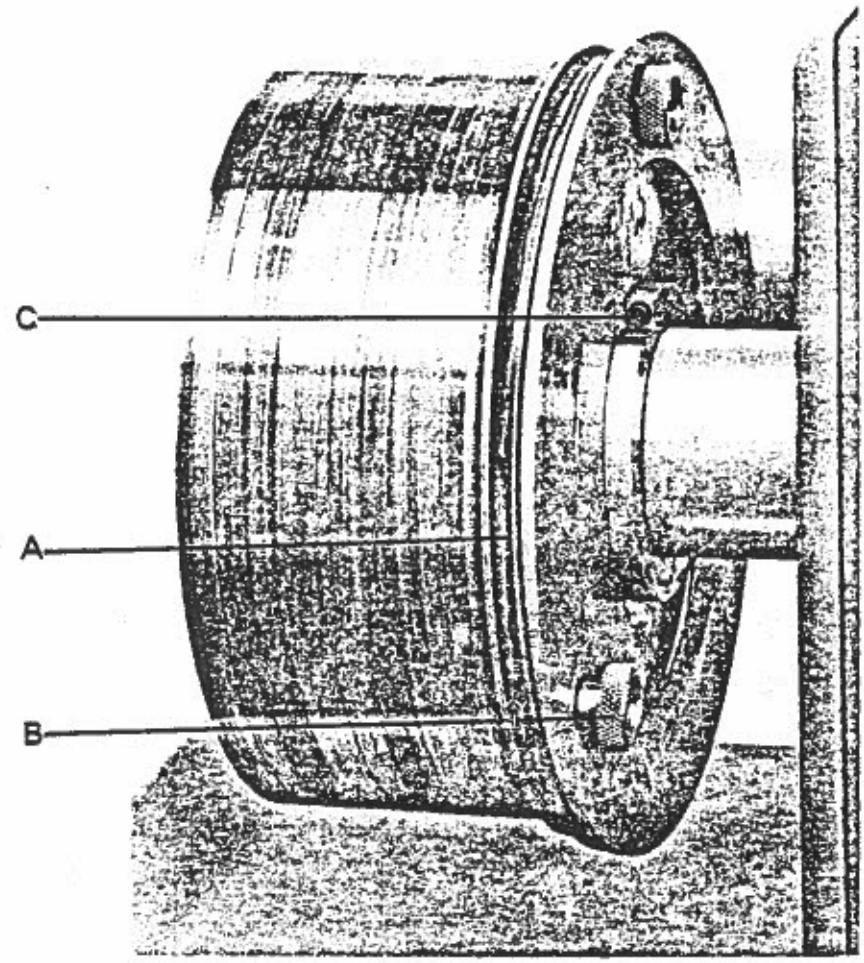


Fig. 4 Rubber seal on cutting head

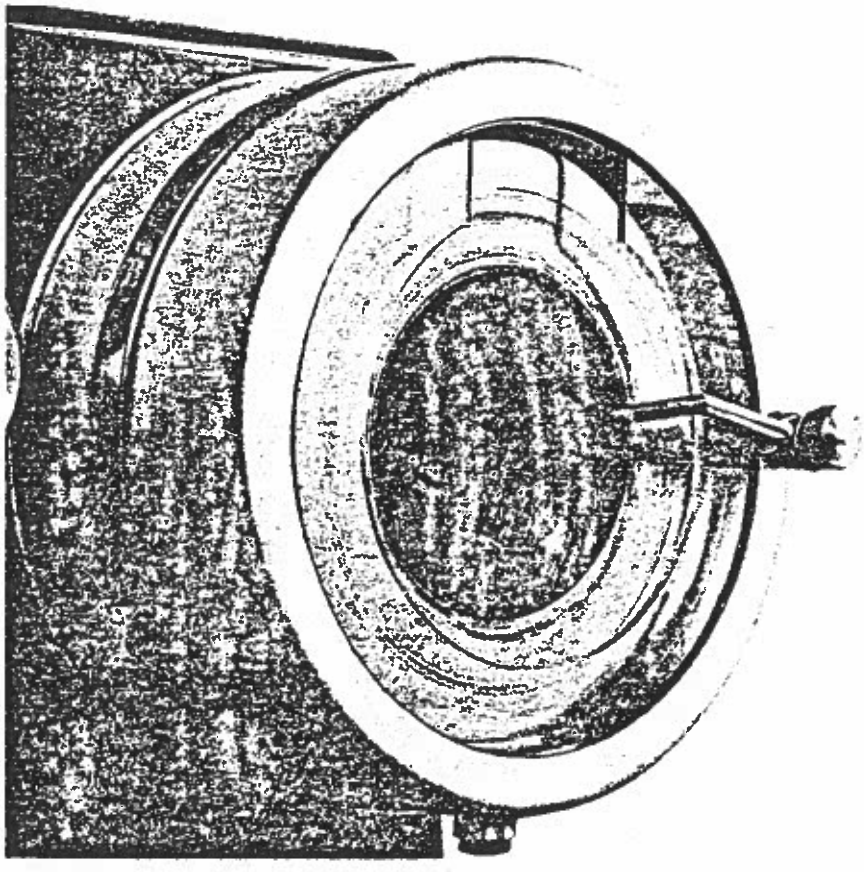


Fig. 5 Blade guard and drain plug

SAWING TECHNIQUE

Annular sawing

Insert the pivot shaft A into the upper hole B and lock in position by clamp C (fig. 6). The pivot action must now be locked by clamp D such that the swing arm will not move upwards to damage the blade. Clamp screw D has a LEFT HAND thread-screw anticlockwise to tighten.

The sample to be cut is mounted on the table provided, E, which is then attached to the sawing arm by means of a universal clamp. The position of the work table is adjusted so that the table forms a chord to the inside periphery of the blade. Care must be taken while these adjustments are being carried out so that the blade is not damaged in any way. The correct weight should now be selected (from the three provided) so that, when it is positioned on the arm, with clamp D released it just balances the specimen and table. If the weight is now moved away from the pivot, the specimen will impart a load on to the table. This load, which can be varied by re-positioning the weight, will depend upon the nature of the specimen and the desired rate of cutting (consistent with the thickness of slice required).

The Microslice can now be switched on and the correct speed selected. The swing arm should be supported and the sample allowed to come gently into contact with the blade. Once cutting has commenced the arm can be completely released and the blade will cut through the sample at its own rate (as described in the section on the See-saw Principle).

After cutting, the machine can be switched off and the pivot arm with specimen attached must be removed from the blade and the pivot action locked, Care must be taken to ensure that the work piece and table are not brought low enough to come into contact with the lower cutting edge of the annular blade.

To produce a parallel cut, the blade can be moved in increments of 0.01mm by means of the control at the front of the machine (fig. 7). The previous procedure is repeated to commence cutting.

Conversion to peripheral sawing

Remove the swing arm and pivot from the machine. Release the three knurled screws on the blade guard back plate and pull the guard off forwards (fig. 4B). Unscrew the central cap head screw retaining the cutting head (fig. 2) and pull the head carefully off its spigot. Unscrew the blade guard back plate split clamp screw (fig. 4C) and pull the back plate from the spindle bearing casing.

The lubricant feed peripheral to blade, cheek plates and nose piece may now be fitted, as described for the Macrotome. Transfer the blanking plug from the lower hole to the upper and place the pivot and swing arm in the lower hole (fig. 7) as described above for annular sawing.

The cutting procedure is then exactly as for the Macrotome. To replace the annular saw head, renew the procedure.

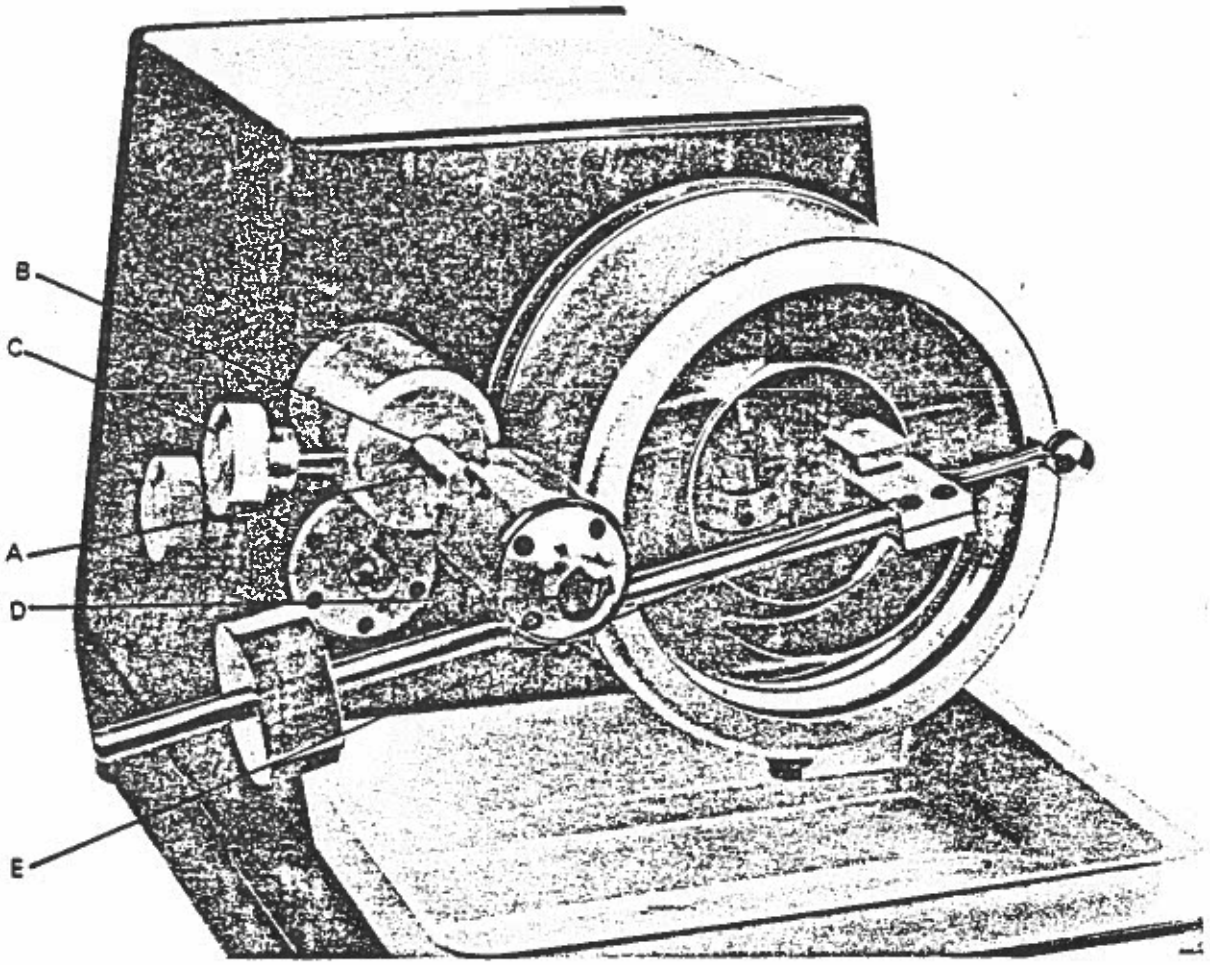


Fig. 6. Assembly of pivot shaft for annular sawing.

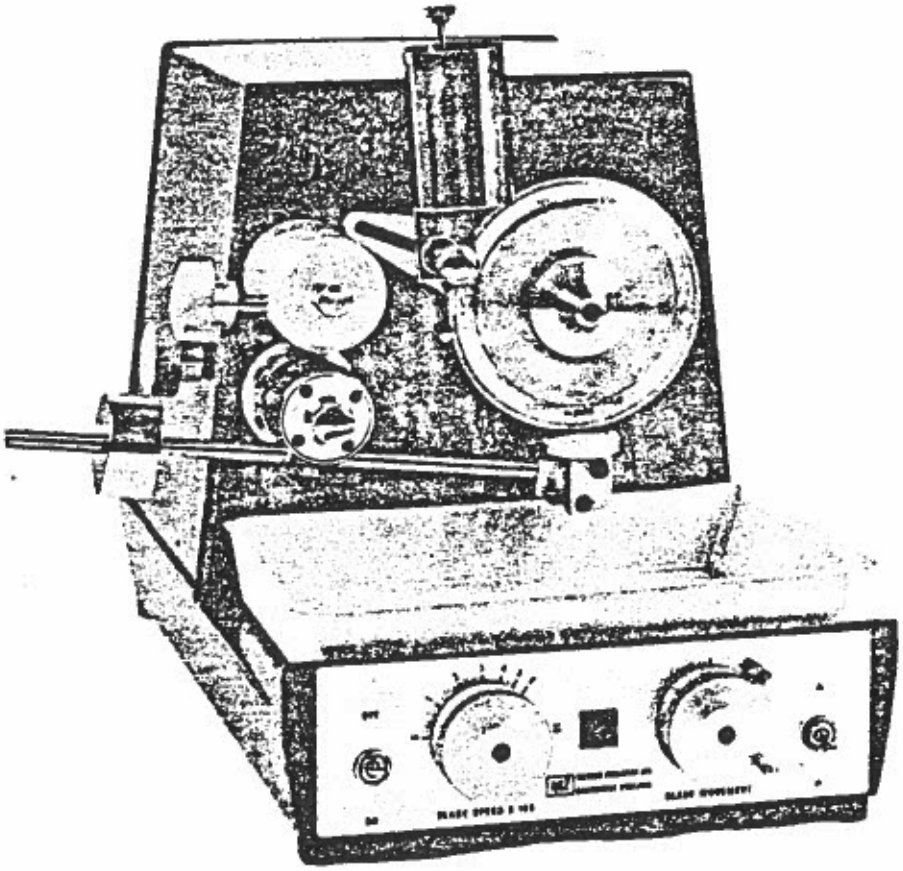


Fig. 7. Microslice 2 adapted for peripheral sawing.

SPECIMEN MOUNTING

The general procedures for the Macrotome Sawing are applicable. The specimen is mounted on a glass strip, which in turn is mounted on the extended finger of the work table. Tan wax is used to encapsulate the specimen and to stick it to the glass. When material is being sawn with related sides, it is an advantage to use the rotational axis of the specimen table (or turntable) in order to avoid having to unfasten, realign and refasten the specimen on the extended finger. The standard practice is to set up the work so that the end sawn is remote from the machine - that is, the specimen is completely within the saw head cavity. This permits the operator to inspect a slice more conveniently. Since one has here the classical case of sawing off the branch on which one is sitting, the rotation stop must be used (as described for the Macrotome) to limit the travel of the counter weight arm to the required arc. If a crystal is being sawn relative to a crystallographic axis, the best practice is to provide it with a reference face on an X-ray room saw. This axis is then re-established by aligning the prepared plane surface on the front of the boule with the sawing plane. A convenient way of achieving this is to remove the cutting head retaining screw from the shaft and, in its place, mount the dial test indicator (d.t.i.) accessory. The stylus is then traversed in two directions, approximately at 90°, one by swinging the d.t.i. on the saw spindle, and the second by moving the work on the damping head spindle. The various degrees of freedom allowed for in the worktable construction are used in order to achieve the required orientation. A check on the uniformity of thickness of the first slice is a good test of the degree of alignment attained.

The boule mounting system is important and ideally should have the following features: 1) rigidity, 2) a base which can be sawn without damage to the blade, 3) wax encapsulation of the crystal to protect the edges, 4) a wax that will not load the saw, 5) an arrangement which provides some space between the boule and the base, which is filled with wax.

This last provision allows either the whole boule to be sawn and left in situ, or single slices to be removed in series as sawing progresses, with a hot wire wax-cutter.

A system which satisfies these requirements is shown in fig . 8. It is in effect a fabricated glass angle plate, made from 6mm thick plate and cemented together with an epoxy resin. At the first stage in the mounting process a small flat is hand-ground on the end of the boule remote from the oriented face. This flat faces the vertical of the glass angle and is positioned with an epoxy resin in the interspace. In order that the boule may be spaced from the base of the angle plate it is packed up with thicknesses of card. The join is now cured at 100°C.

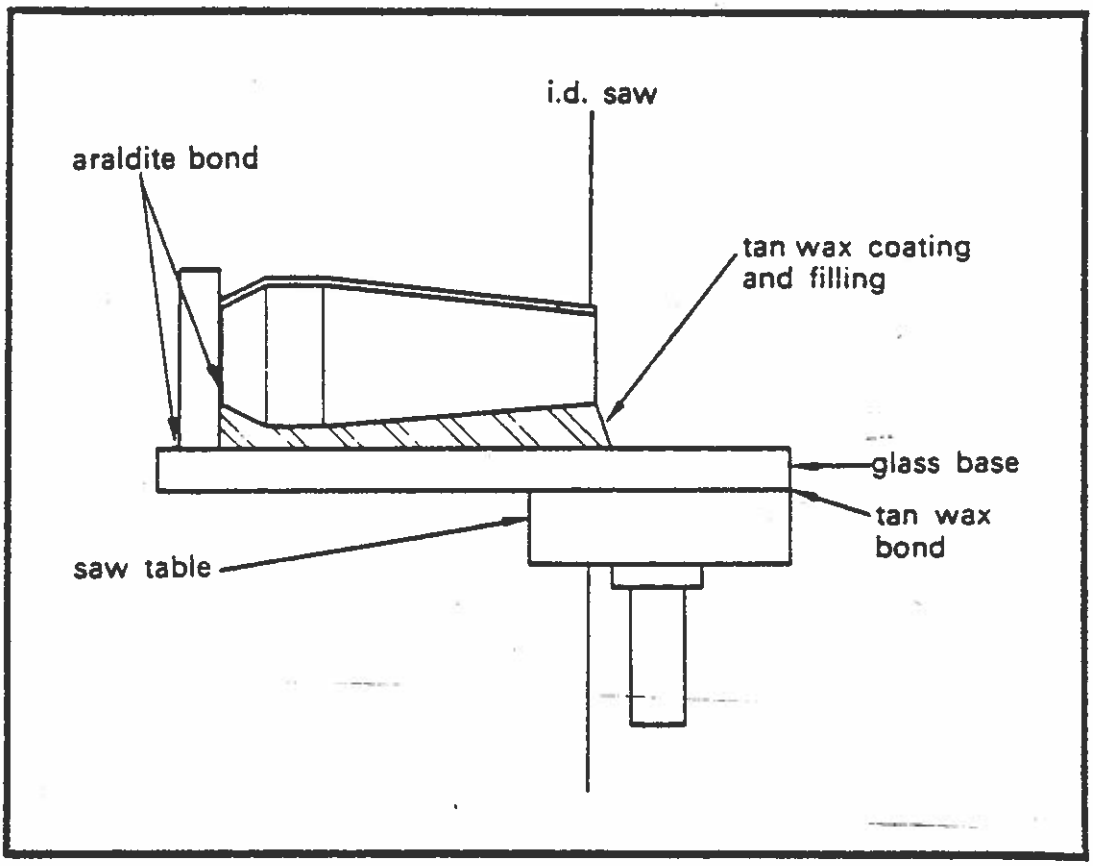
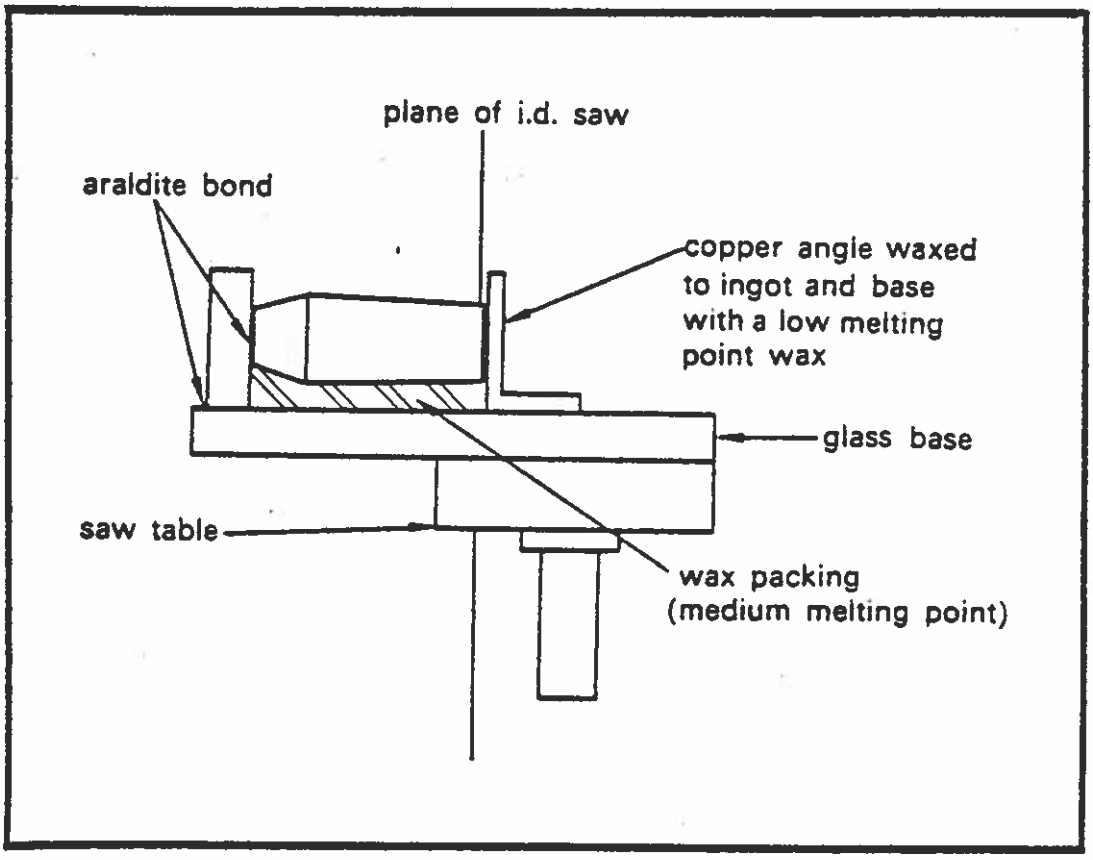


Fig. 8 Ingot prepared for cutting



Before the assembly cools, the whole of the exterior of the boule is coated with Tanwax and the space left when the packing card is removed is allowed to fill as well. By this means the whole of a boule may be cut with each slice retained in place, firmly held in the bed of wax at the bottom and protected around its periphery. Alternatively each slice may be removed by the hot wire cutter.

The techniques so far described are satisfactory for a wide range of delicate materials, but there are those that do not give repeatable results below 600 μ thickness. Notable amongst these are lead telluride (PbTe) and indium arsenide (InAs), and in order to obtain slices down to 200 μ thick, it is advisable to give each individual slice some face support (fig. 9). This is done by using an 18mm length of 18 x 12 x 12 mm nickel plated copper angle plate waxed to the face of the boule. It is achieved by warming the angle section and melting on a liberal coating of a wax with a melting point circa 80°C. The hot waxed angle is then pressed lightly against the exposed end of the boule and allowed to cool. This bonds the end of the boule to the glass base and a cut made for the required thickness is permitted to enter the glass. The angle plate is removed with the slice in situ by applying a pulse of heat from a small soldering iron which melts the wax locally. The slice itself can be allowed to slide off under its own weight when warmed in an oven or over a hot plate.

The vicinity of the boule end is quickly cleaned - for example, with an aerosol degreasing agent - and the angle plate rewaxed in position. On the rare occasion when heat sensitive materials have to be thin-sliced, temporary support is given to the specimen by use of a thick grease, or an embedding resin, such as acrulite or a standard polyester glass or slate-filled resin. The slices are separated by soaking in dichloromethane to remove the polyester resin; the polymethylmethacrylate is best treated by immersion in agitated chloroform.

ACKNOWLEDGMENT

The cutting techniques described above were developed at the Royal Radar Establishment, Malvern, England.

Examples of materials cut on the Microslice

Material Cut	Typical blade speed (r.p.m.)	Typical load (g/cm cut length)	Kerf loss (microns)	Blade type (grit size)	Surface finish (micro inches CLA)
Gallium Arsenide	180	50	175	280	12
Gallium Phosphide	180	50	150	FX	12
Indium Arsenide	150	30	150	FX	12
Indium Phosphide	150	30	150	FX	12
Lead Telluride	150	20	150	FX	6
Cadmium Telluride	150	20	150	FX	12
Lithium Niobate	200	50	175	280	8
Proustite	150	20	175	280	16
Tri-Glycine Sulphate	150	30	150	FX	12
Rutile	200	50	175	280	8
Spinel	200	50	175	280	8
Crown Glass	200	50	150	FX	8
Quartz	200	50	175	280	8
KDP, ADP,	150	30	150	FX	12
Yttrium Aluminium Garnet	200	50	175	280	8
Silicon	200	50	150	FX	8
Brass	200	40	150	FX	6

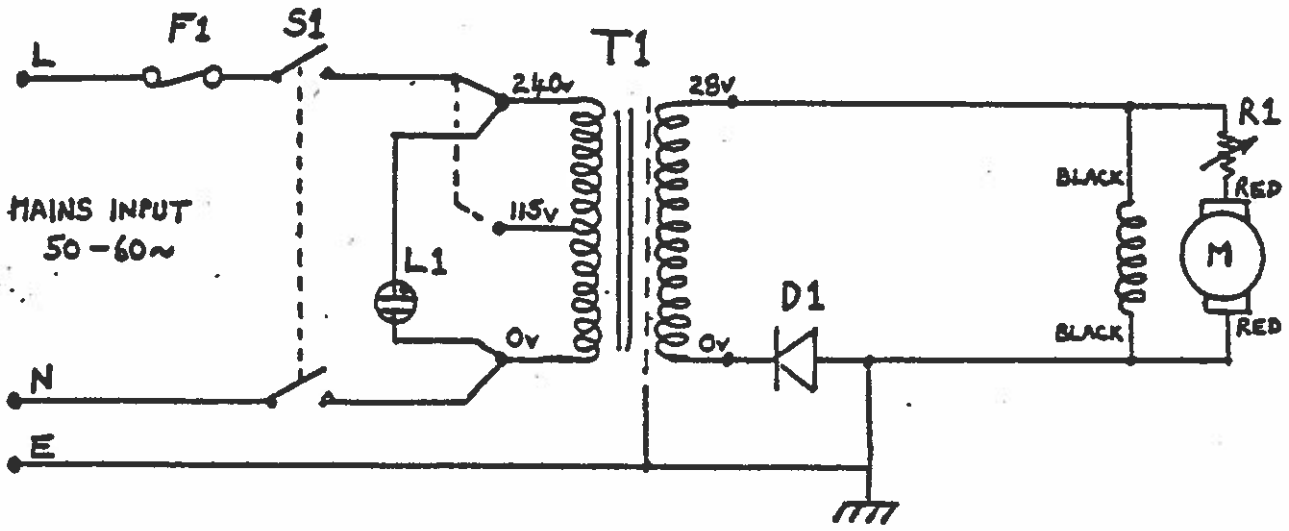
Precautionary Notes

1) The quality of saw cut produced will always depend upon the quality of the blade, the correct loading and correct speed. The quality of the blade is most important and it is most inadvisable to use a damaged blade. Damage usually occurs in two ways:

a) by chipping the blade due to bad handling
b) by twisting the blade due to excess pressure being exerted.

Thus, it is extremely important to prevent knocking the blade with the swing arm or specimen, or allowing the blade to seize up in the specimen due to excess loading.

2) It is sometimes necessary to 'dress' the saw blades by lightly holding a piece of alumina or similar material against it. This is always necessary when cutting plastics, which might clog the blade and lead to seizure.



M	TYPE SD11
T1	TYPE 1278
R1	PX50/12.5 ohm/16F
D1	TYPE 6F10
L1	SGF 1717/220
S1	TYPE 8370/K7
F1	TYPE L1348
Fuse	TYPE L1055-5A

Fig .10 CIRCUIT DIAGRAM
MICROSLICE 2